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## CONTENTS:

| | PAGE |
|---|---|
| Fusible and Mechanical Cut-outs | 425 |
| The Precision of Electrical Engineering (*concluded*) | 427 |
| The Rating of Resistance Spirals (*illustrated*) (*concluded*) | 427 |
| Electricity in Mining: Advantages of the Alternating Current (*illustrated*) | 429 |
| Cut-outs | 430 |
| The Boston Subway (*illustrated*) | 431 |
| Correspondence:—*Re* Donaldson's Gas Engine | 433 |
| Electricity Supply Centralisation | 433 |
| The Engineers' Strike | 435 |
| Electrolysed Sea Water | 435 |
| Business Notices, &c. | 436 |
| Electric Lighting Notes | 438 |
| The Dover Electrical Tramways (*illustrated*) | 439 |
| The Advantages of Synchronous Motors in Alternating Current Stations | 442 |
| Electric Traction and Motive Power Notes | 444 |
| Telegraph and Telephone Notes | 445 |
| Contracts Open and Closed | 445 |
| Glasgow Telephone Service | 446 |
| Notes | 447 |
| City Notes | 449 |
| Traffic Receipts | 449 |
| Share List of Electrical Companies | 450 |
| The British Association for the Advancement of Science:— Some Tests on the Variation of the Constants of Electricity Supply Meters, with Temperature and with Current (*illustrated*) (*concluded*) | 451 |
| A Method of Determining Magnetic Hysteresis Loss in Straight Iron Strips (*illustrated*) | 454 |
| New Patents and Abstracts of Published Specifications | 456 |

## NOTICE OF REMOVAL.

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## FUSIBLE AND MECHANICAL CUT-OUTS.

IT is greatly to be regretted that so little has been done to produce a reasonably copious technical index. Were such available, there are many subjects on which the average electrical worker would be better informed, or, at least, the path to knowledge would be cleared of many difficulties. For example, the various factors entering into the causes underlying the variability of fuse metals have been pretty thoroughly examined; but not one in a hundred of those who have to fix and maintain fuses are acquainted with a tithe of the memoirs and papers dealing with the question, and much less is generally known about the subject matter.

Now, why are fuses so unreliable? To answer this question fully would require us to specifically state the weaknesses and defects in the articles which "accessories" manufacturers place on the market, and list in their catalogues. Very few of these are constructed as they ought to be, yet one has only to turn to Mr. A. C. Cockburn's paper of 10 years ago, and there will be found a complete statement of the requirements to be met (*Journal*, Soc. Tel. Eng., Vol. xvi., p. 658). To bring this up to date, there need only be added, "Covers to be ventilated," and, in addition to the "definite breaking point" insisted upon by Mr. Cockburn, "the circuit to be broken as instantaneously as possible."

We have so often insisted upon the importance of the time factor, that the article we publish elsewhere in this issue, describing Messrs. Clark and Macmullen's investigation, is decidedly welcome. It is only comparatively recently that this point has received the attention its importance merits, although in the old days, when fuses were used to protect telegraphic apparatus and nothing else, it must have been recognised as a desirable attribute in the protecting device.

Many attempts have been made to secure a quick action. Among the better known are the weighted fuse, invented by Prof. S. P. Thompson in 1879, and afterwards modified and put on the market by Mr. Cockburn; the spring fuse of Lord Kelvin and Messrs. Laurence, Scott & Co.; the knock-off switch introduced by the old firm of Messrs. Goolden and Trotter, and others following similar lines. The Cunynghame cut-out, and afterwards the Prentice pattern, have been largely used among the mechanical devices.

Coming to the theoretical side, we find the ground fairly well covered. Prof. Forbes and Mr. Preece have investigated the heating effects of currents, and the fuse tables of the latter, as given in his 1887 Royal Society paper, are the source from which most fuse makers draw their inspirations. Mr. W. E. Harrington has been a prolific writer and experimenter on all matters connected with cut-outs and fuses, and

his papers in the *Proceedings* of the American Institute of Electrical Engineers, the American Street Railway Association, and the National Electric Light Association, U.S.A., are mines of information. Two years ago he published some experiments made to ascertain what current would flow through fuse metals on 500-volt short circuits. His method of measuring the current was certainly not to be compared, so far as accuracy goes, with the elegant—to borrow a term from the mathematician—means employed by Clark and Macmullen; but this is, perhaps, the only criticism. At worst, his tests formed a practical comparison between cut-outs and fuses.

What is now wanted is a systematic attack on materials in every-day use for fuses, and a thorough examination of the various made up fuses to be bought from dealers to-day. There is, notwithstanding all the work done by individual experimenters, the Institution of Electrical Engineers, the Verband Deutscher Elektrotechniker, and others, plenty of room for further research *under practical conditions*. We will mention two points to which the direction of the advanced student, who is looking for a subject to sharpen his wits upon, might be directed. The first is, to prove whether a short circuit has any sense of time or respect for cut-outs or fuses; and secondly, why is it that alternating current fuses give so much trouble compared with those on direct current circuits? Whoever ventures to tackle this work might do worse than start by reading Prof. Nichol's instructions and suggestions (*Laboratory Manual*, Vol. ii., p. 74), and before deciding upon the method of measuring current and time, Mr. Leonard Andrew's experiments upon the instantaneous breaking current and rupture epoch of automatic cut-out switches (Northern Society of Electrical Engineers' paper) might be consulted.

Now we know from bitter and repeated practical experience, that a decently made fuse, such as put in by a supply company in their street box on a service line, will always—there need be no qualification to this—melt on a short circuit before the consumer's main fuse put up on the wall near the meters by the wiring contractor. What is not yet known is the effect of paralleling a number of fine wires compared with a solid wire of the same material and equal melting current, when this is increased slowly and steadily until rupture takes place. Again, thin rolled-out strips of fusible alloy are often used; but little is known outside the maker's shops about their true carrying and melting currents.

Coming to the other question, it will be recalled to mind that Mr. C. P. Matthews endeavoured to prove that alternating currents had an effect in lowering the fusing points of wires (*Trans.* Amer. Inst. E. E., Vol. 10, p. 251). This, curiously enough, is sustained by practical experience, if no other cause can be found; but the carefully conducted investigation of Prof. D. C. Jackson and Mr. R. J. Ochsner led to the conclusion that "fuses on alternating current circuits are sometimes found to blow without apparent reason, but something outside of the disintegrating effect of the current is the cause. Under some conditions, the result has come about through the mechanical shaking to which an alternating current fuse is sometimes subjected when not tightly clamped by the terminal screws."

It is a curious commentary on this that some alternating current station engineers are bothered once or twice a week by being called to replace consumers' fuses that have gone without apparent cause. Our columns also bore witness to the fact that within a week of one another the Vestry meetings in two important Northern parishes were plunged into darkness some 18 months ago by the melting—not blowing—of their respective main fuses, and in each case the supply was alternating. Why these things should be is what we all want to know, but it is a well-known fact that in such cases fuses do melt, and no cause can be found, or even a reasonable explanation put forward: considering that the fuse is a bugbear alike to supply company and customer, it is really time that all interested in continuity of supply gave close attention to the subject until it is divested of some of its present mystery.

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**The Municipalisation of Telephones.**

The Treasury enquiry into the question of the municipalisation of telephones which was opened on Tuesday last at Glasgow will, no doubt, be followed with the greatest interest, not only by telephone men and the electrical profession generally, but by those interested in the widening of municipal operations. We have had a good deal to say on the question at different times, and while we are not inclined to modify the opinions we have already expressed on the question of the municipalisation of telephone services, we are confident that the enquiry, if conducted on broad lines, will dispel many illusions that are very prevalent. One has been often told, by Scotch papers, that the municipal government of Glasgow is the best in the world, and, no doubt, much has been done to ameliorate the condition of those who are compelled to live in Glasgow. Should it come to pass, however, that a Glasgow municipal telephone system became an established fact, we trust its attainment may be accomplished without indulging in that penchant for conducting enquiries in foreign lands that is a distinguishing characteristic of Glasgow committees, and it would be a matter for profound regret if any dispute were to arise as to the proper committee to supply the electrical current necessary to work the telephone system.

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**Glasgow and Electrical Progress.**

Although Glasgow may consider itself in many respects the centre of light and leading, it has by no means made astonishing progress in municipal electrical work. The population of Glasgow is 657,000, and the rateable value £4,046,726; Manchester, on the other hand, has a population of 530,000, and a rateable value of £2,911,083. Curiously enough, the municipal control of electric lighting commenced in the two cities within a few months of each other, but the latest returns show a marked difference in the two systems, as will be seen from the following figures:—

| | 25 watts lamps. | Units sold. | Revenue. |
|---|---|---|---|
| Manchester ... | 123,595 | 1,748,244 | £38,253 |
| Glasgow ... | 79,140 | 1,090,959 | £25,862 |

For years past the Glasgow Corporation has owned probably the most paying system of tramways in the kingdom, and four or five years ago a committee collected an amazing mass of information on the subject of working tramways by electrical means; moreover, it was generally accepted that electrical working was far and away the best system. Four years ago the tramways in Leeds were owned and worked by a company, yet to-day the Corporation of Leeds has not only taken over the whole of the city tramways, but has equipped 10 miles with the overhead trolley system—and Glasgow to-day is in a difficulty about running a short experimental line on the same system. Notwithstanding, Glasgow has sufficient confidence in itself to be desirous of acquiring and working a telephone system.

## THE PRECISION OF ELECTRICAL ENGINEERING.*

By FRANCIS B. CROCKER.

(*Concluded from page* 424.)

We naturally suppose ourselves to be familiar with mechanical energy and heat; but as soon as we convert these well-known forms of energy into that extremely subtle and mysterious agent—electricity—it immediately becomes far more definite and convenient to control, measure, transmit and utilise. In becoming intangible, it forthwith acts as the most reliable and matter-of-fact tool in the hands of those familiar with it. For example, the quickest, neatest, and most exact method of making a test of mechanical friction, or the power required in any given case is by the use of an electric motor. In this way, for example, we can determine the friction of different bearings or lubricating oils under various conditions of pressure and speed, or the power consumed by fans, pumps, and other machines.

Quite a striking example of the possibilities of electrical measurement is the determination of the E.M.F. of a dynamo machine without running it, which I saw successfully carried out more than 10 years ago. All that is necessary is to measure the torque exerted by the machine with a given current in its armature. This may be accomplished by simply clamping a stick of wood to the pulley and weighing the pull at a given radius by means of a spring balance. If the same machine were run as a dynamo and had no losses, it follows that

$$\frac{E\,I}{746} = \frac{2\,\pi\,r\,S\,P}{33{,}000},$$

whence

$$E = \frac{r\,S\,P}{7{\cdot}04\,I},$$

in which $r$ is the radius at which the pull is measured, S is the speed in revolutions per minute at which the dynamo is to be run, P is the pull in pounds at the given radius, and C is the current in amperes. The field strength is supposed to remain the same. This method is correct whatever the efficiency of the machine may be. The electrical and magnetic losses due to the $C^2\,R$ effect in armature, field current, eddy currents and hysteresis, do not enter this problem. Even the mechanical losses arising from friction of bearings, brushes, &c, may be eliminated by measuring the pull plus the friction and then minus the friction, the actual pull being one-half the sum of these two results. The effect of friction may also be gotten rid of by tapping the shaft when the measurement is made. It certainly strikes one as strange that E.M.F., which depends upon cutting lines of force, can be determined while the machine is standing still.

In electro-chemistry and electro-metallurgy quantitative relations are particularly precise. The ampere being defined as the current which deposits ·001118 grammes of silver per second, the weight of any other substance is by Faraday's laws proportional simply to its chemical equivalent. This definition eliminates any error in passing from the electrical to the chemical data, or *vice versâ*. The volt is also defined electro-chemically in terms of the E.M.F. of a Clark cell.

The author presented before the Institute in May, 1888, a paper on "The Possibilities and Limitations of Chemical Generators of Electricity,"† in which the weights of materials, E.M.F., and other data were given for various voltaic combinations. Some of the figures were obtained by experiment, and some by calculation. The paper also gives the E.M.F. produced by combinations of 13 of the most important metals with chlorine, bromine and iodine, respectively. The average difference between the calculated and tested values was less than $\frac{1}{10}$th of a volt. Even this small error is practically eliminated when the results are corrected by the equation of Helmholtz; that is, by adding the quantity $\pm\,T\,\frac{d\,E}{d\,T}$, in which T is the absolute temperature, and E is the E.M.F. of the cell. Since the weights of materials liberated or consumed by a given current in a given time can be definitely pre-determined, and the voltage due to a certain chemical combination can also be accurately calculated, almost any problem in electro-chemistry or electro-metallurgy is susceptible of being quite easily and correctly solved.

That branch of electro-chemistry and metallurgy which employs electrical heating methods is also very definite, the exact amount of heat in gramme-degrees produced by an electric current being always given by the simple expression, $\cdot24\,I^2\,R$, or $\cdot24\,E\,I$.

In support of the proposition advanced in the title of this address, I am able to produce most interesting personal testimony. Mr. Edison and Mr. Tesla have independently expressed to me their opinion that electrical knowledge had become so definite and general, that almost anyone could apply it, and comparatively little opportunity was left for invention. They believed that chemistry and thermodynamics were far more uncertain, and therefore offered a much better field for improvement. These views were expressed several years ago, and subsequent events have shown that they contain a great deal of truth. It is a fact that electrical engineering has advanced along the lines laid down by these and other great inventors, and it is also true that much of the work has been done by the rank and file of the profession. The trails blazed by the pioneers have since become broad highways with many branching roads, built for the most part by common workmen. On the other hand, the discovery of the Röntgen ray has since been made, and both of these investigators have given much valuable time to it. It would seem, therefore, that the electrical principles and laws of to-day are true for all time, and afford a firm foundation for unlimited future progress, but that there are also many additional facts yet to be discovered that are well worthy of the efforts of the greatest genius.

In conclusion, the following quotation from the preface of Maxwell's great work on "Electricity and Magnetism" is appropriate. "The important applications of electromagnetism to telegraphy have also reacted on pure science by giving a commercial value to accurate electrical measurements, and by affording to electricians the use of apparatus on a scale which greatly transcends that of an ordinary laboratory. The consequences of this demand for electrical knowledge and of these experimental opportunities for acquiring it, have been already very great, but in stimulating the energies of advanced electricians, and in diffusing among practical men a degree of accurate knowledge which is likely to conduce to the general scientific progress of the whole engineering profession."

These words were written in 1873, and yet they show strong confidence in the accuracy of electrical methods and full appreciation of the close relationship between electrical science and engineering, as well as their beneficial effects upon each other. At that time the telegraph was the only practical application of electricity. What language would express Maxwell's wonder if he were alive to-day!

* Inaugural Address of the President at the 14th general meeting of the American Institute of Electrical Engineers, Eliot, Me., July 26th, 1897.

† *Transactions*, Vol. v., p. 227.

## THE RATING OF RESISTANCE SPIRALS.

By V. ZINGLER, A.I.E.E.

(*Concluded from page* 397.)

The next table shows a series of observations with galvanised steel spirals, on the same principle as those made with platinoid, but with the addition that three different current densities and their corresponding resistances per foot are given.

With spirals wound on a $\frac{7}{8}''$ mandril the charring point of paper is just reached at about 300 watts per foot, and at 200 watts per foot with a $\frac{1}{2}''$ mandril, when rigidly stretched.

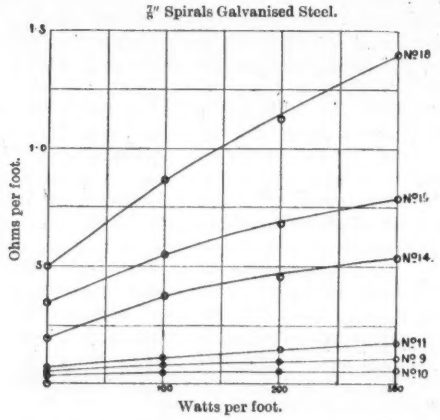
For ordinary regulating resistances 200 or 100 watts per foot for $\frac{7}{8}''$ and $\frac{1}{2}''$ spirals—presumably boxed in—will be found quite sufficient, especially as the effect of change in resistance due to higher current densities will not be felt. For starting resistances, shunt breaking, or large accumulator switches, where the current is only switched on for a short period and the resistance does not require to be very accurate, 300 and 200 watts per foot will be found more convenient for $\frac{7}{8}''$ and $\frac{1}{2}''$ spirals. But all these points should depend on

the wire actually used, and the special use to which it is to be put, together with a certain latitude of judgment for the tester and the designer.

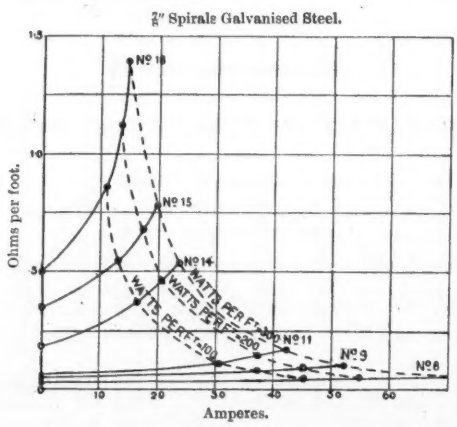
Tests of Galvanised Steel Spirals.

| S.W.G. | Diameter of Spiral. | Res. per foot cold. | Lbs. per foot. | Turns per foot. | 100 watts per foot. | | | 200 watts per foot. | | | 300 watts per foot. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Res. | P.D. | Amperes. | Res. | P.D. | Amperes. | Res. | P.D. | Amperes. |
| 8 | ⅞ inch | 0[illegible] | 67 | 34 | ·05 | 2·25 | 45 | ·155 | 3·3 | 61 | ·06 | 4·25 | 71 |
| 9 | ,, | ·055 | ·63 | 41 | .08 | 3·0 | 37 | ·095 | 4·5 | 45 | ·11 | 5·75 | 54 |
| 11 | ,, | ·067 | ·53 | 50 | ·115 | 3·5 | 30·5 | ·145 | 5·5 | 37 | ·17 | 7·25 | 42 |
| 14 | ,, | ·194 | ·26 | 55 | ·372 | 6·1 | 16·4 | ·458 | 9·33 | 20·37 | ·53 | 12·6 | 23·7 |
| 15 | ,, | ·350 | ·25 | 60 | ·55 | 7·25 | 13 | ·68 | 11·75 | 17·3 | ·78 | 15·25 | 19·5 |
| 18 | ,, | 501 | ·11 | 48 | ·865 | 9·5 | 11 | 1·12 | 15 | 13·4 | 1·39 | 20·25 | 14·6 |
| 14 | ½ inch | 151 | ·19 | 60 | ·29 | 5·5 | 18·9 | ·38 | 8·75 | 23 | ·45 | 11·75 | 26 |
| 15 | ,, | ·204 | 16 | 60 | .38 | 6·25 | 16·4 | ·5 | 10 | 20 | ·61 | 13·5 | 22 |
| 17 | ,, | ·252 | ·12 | 60 | ·51 | 7·26 | 14 | ·67 | 11·75 | 17·5 | ·83 | 15·75 | 19 |

These tables are more methodically taken than those for platinoid, and it will be observed that the No. 18 spiral instead of having more turns per foot (which have been going up as the gauge decreases) has less. This can be accounted for by the fact that there must be a point at which the number of turns and the strength of wire clash, owing to the wires of finer gauge not being strong enough to




support themselves, especially for large diameter of mandril. This bears out the remarks made before, and shows that the rough rule given only holds within small limits, and that is all for which it is required.

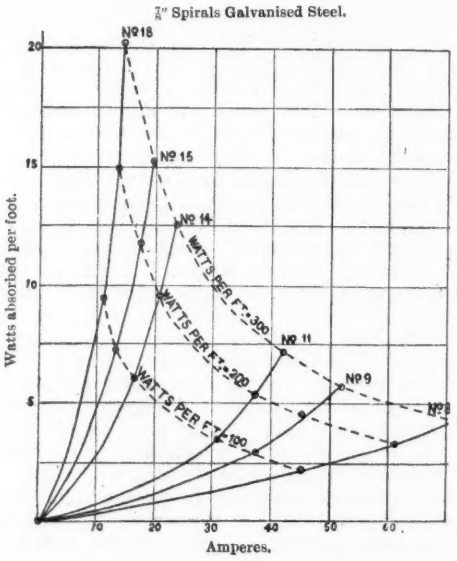



From the above observations three sets of curves are here given. With such curves before him, any designer of resistances would find his work considerably lightened, but—as explained before—the tests should be specially made.

It is, of course, unnecessary to add that due allowance must be made for what might be called mutual heating of spirals, in an enclosed space; also that, as spirals are usually more than one foot long, allowance should be made for the extra weight either by stretching them further or by supporting them on a bar in the centre. It should also be remembered that heat rises, and the top turns of enclosed spirals will always be hotter than the bottom turns. This is, however, slightly compensated for by the top turns softening, and these then tend to stretch out further, due to the pull of the bottom spirals. This is perhaps, however, also stretching a point against the factor of safety which our tests should allow for.

Spirals placed on tubes or inside tubes need not be wound on, but simply slipped on the tube—the physical properties of the spiral being perfectly defined from our tables.

There are several ways of winding continuous spirals by machinery, and perhaps the simplest is to make a template for each different gauge of wire used, by cutting notches at convenient lengths, and at a slight angle—the diameter of the notch being such that the gauge clears easily.




This template is then fixed in a slide rest, and brought up to and parallel with the side of a mandril tapered outwards to the necessary diameter. The wire is then first started by hand round the mandril and through the notches. The latter is then set to work in such a direction that the wire is actually *screwed on* by means of the inclined faces of the notches in the template—and the spiral continues to run out automatically until stopped. This is shown conventionally in the figure.

There will no doubt be many who will prefer to stick to their Wheatstone bridge and known (or fancied) current carrying capacities of wire spirals, owing to want of energy or facilities to make such tests, so that it may be said that every resistance made by them is a special one. But bearing in mind the exceedingly useful tables of qualities of charcoal iron published and guaranteed by manufacturers, it might not be inept to conclude with a hope that wire drawers will one day supply their customers with some such particulars for wires which they sell for resistance purposes.

## ELECTRICITY IN MINING: ADVANTAGES OF THE ALTERNATING CURRENT.*

The comparatively recent developments in the manipulation of alternating current electricity have, in broadening the whole field of electrical application, extended the use of the current also in the mining industry, and given to the mine operator a system extremely efficient and flexible, both in its distribution and adaptation. The alternating current possesses one great advantage, among others, which no other system presents, in the ease with which the voltage may be varied. This is done by means of transformers, and allows the electricity to be transmitted at a high voltage, and, consequently, cheaply, over long distances, to be transformed down at the point of utilisation. It also allows of the use of motors which, equally effective in their performance with direct current motors, are free from commutators and moving contacts, and, consequently, from sparking, as well as from other shortcomings.

To the mine operator the alternating current system, or rather a modification of it, known as the three-phase system, offers special advantages. Mines many miles apart may be operated by current generated at a single central point, situated where it can be procured and distributed most economically. The electricity, transmitted at a suitable high voltage, on reaching the mine mouth is reduced in pressure, and the wires taken down the shafts carry a low voltage current only. It can then be used not only to drive the mine machinery, but also to light the arc and incandescent lamps on branches from the same main circuits at even a lower voltage than that used for the machines. In case continuous current is required in lieu of alternating, as for the operation of mine locomotives, the alternating current can be converted into a continuous, in a rotary converter, and the voltage of the latter current regulated to the necessary pitch for the new use. Furthermore, although three wires are used with the three-phase system, and two with the direct, the cost of the three wires is one-quarter less than that of the two wires, allowing the same loss in transmission and using the same initial voltage.

To the cutting of coal by machinery, the three-phase system seems peculiarly suited. The chain coal-cutter, illustrated, shows the latest type—a stationary frame and travelling carriage carrying the motor, driving gear, feed gearing and cutting chain. The motor is an induction motor laid on its side. It has neither commutator brushes nor moving contacts, and, as it cannot spark, can be used in gaseous or dusty mines, where a spark might result in a costly disaster. The windings of the motor are stationary coils embedded in metal and protected from injury, and as these coils are separately formed and insulated, they may be readily removed and replaced. The motor is entirely enclosed, and no starting box being necessary, complete control is given by a simple enclosed switch. The motor stops work the moment it is overloaded, and the machine is thus subjected neither to strain nor breakage. The shaft of the motor is vertical and runs at a low speed, allowing the chain sprocket wheel to be driven by a single reduction spur gear, thus avoiding on the main drive both worm and bevel gears. The feed gearing is driven by a worm at the lower end of the armature shaft. The backward thrust of the feed gearing is taken by a single rack so located as to compensate largely for the side thrust of the chain as it cuts the coal. Into this rack mesh two pinions, one for the forward and one for the backward motion of the carriage. The reverse lever at the back of the machine throws clutches in or out of these gears, and is arranged to throw automatically when the end of the cutter travel is reached. A characteristic feature of this cutter is the small amount of gearing employed, and the reduced number of wearing parts.

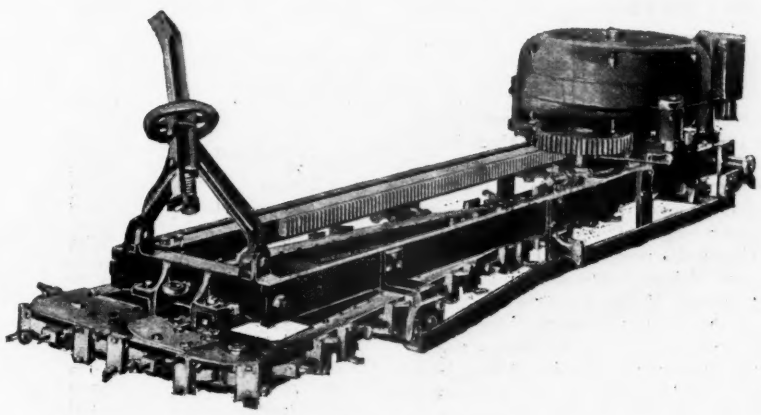


Fig. 1.—Chain Coal Cutter.

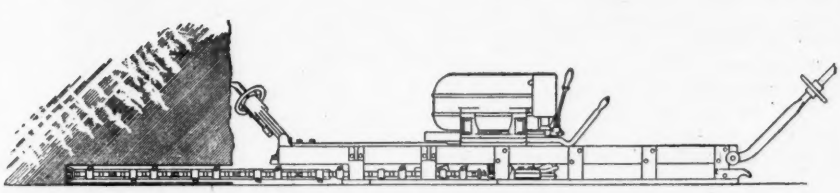


Fig. 2.—Method of Operating Chain Coal Cutter.

The chain is arranged to take three shapes of bits, each form cutting grooves about one and one-half inch deep, separated from the next groove by a ridge of coal, which is broken down by the links. The cut is about 4 inches high × 36 inches wide, and the bits made in the form of an arc of a circle can be set out as required. This gives a great advantage in sharpening, as no part of the bit, except the cutting edge, needs re-dressing, and all of the steel may be used up. The chain is built to stand the strain and the vibration of the cutter. The bit links are of tough phosphor bronze, and the strap links are steel drop forgings of such shape as to bring all the strain directly upon the solid forgings, and not on the rivets.

In rooms where the proper clearance can be obtained, this coal-cutter can be shifted or moved from the first position ready for a second cut in an average of two minutes, it being

* Abstracted from the New York *Electrical Review*.

understood that the props are away from the face, the floor reasonably smooth and the face of the coal properly squared. The time of loading and moving the cutter from room to room will average about 15 minutes, provided the rooms are adjacent. The time required for setting the bits will average 10 minutes. The cutter has, in favourable coal where other conditions were rather unfavourable—such as roof, props, track, &c.—been able to average eight cuts or runs, each 36 inches wide, per hour, or at the rate of 240 lineal feet per 10-hour shift. The conditions can scarcely be so unfavourable that it will not always be able to average at least four runs per hour.

## CUT-OUTS.

By ED. C. DE SEGUNDO, A.M Inst.C.E.

A little experience in endeavouring to train electricity in the way it should go is sufficient to show that if there is one thing more unreliable than another it is a fuse, or cut-out. A good deal has been written on the subject, and experiments innumerable have been made to determine the exact carrying capacity of a given length of a given gauge of fuse wire having a given chemical composition, but such considerations as the usual size of fuse frames used in the trade, size of terminals, not to speak of the somewhat divergent views held by wiremen as to what is a "suitable" place for a fuse, are not taken into account in most laboratory experiments, with the result that however interesting it may be to know that a certain length and quality of fuse wire melted with an average current of 6·521873 amperes when tested in a laboratory, when under a glass case kept at 60° F. with the barometer at 29·9995, such results give no clue as to what current that size wire will carry when shut up in a 1¼ inch china box, and fitted directly over a gas bracket within a foot or 18 inches of the burner, or when placed in the basement near the outer door, from the top of which a refreshing draught continuously blows upon the wire, the cover having perhaps been broken off or forgotten.

Then however accurately the fuse may have been selected, its efficiency and reliability is impaired by the recurrence of currents which may be much or little above the normal, and yet not sufficient to cause fusion. Fuse wires also oxidise; and, perhaps, the most important and objectionable characteristic is their capacity to allow a large current to pass for a sufficient time (though this may be a short interval) to do damage to conductors or surrounding objects.

In the magnetic cut-out many of these faults exist only in a very modified degree; and some are, indeed, eliminated. Of course, a magnetic cut-out cannot well be made for smaller currents than 4 or 5 amperes, and is much more expensive than the ordinary "fuse" of commerce; but there can be no doubt that the use of a well-designed magnetic cut-out for controlling large currents is preferable to that of lead or copper strips.

A very important element in the action of cut-outs is the time that elapses between the epoch at which the catastrophe occurs and that at which the current is broken. So far, no systematic investigations into this have been made, at least, so far as I am aware, and the researches of Messrs. C. M. Clark and C. W. Macmullen, of the Columbia University, in this direction are of peculiar interest.

Separate sets of tests were carried out on a magnetic cut-out with carbon contacts, some with mercury contacts. The cut-outs were set to act at a certain current density, and the quantities measured were (1) the actual current passing at the time the cut-out broke the circuit, and (2) the time that elapsed between the closing of the switch, which caused an abnormal flow of current and the breaking of the circuit.

The method of measuring the current was as follows:—The main current was taken through the primary of an air core transformer, and a properly calibrated ballistic galvanometer with a large period of vibration connected in series with the secondary. The increasing field due to the increasing current in the primary (in the course of a test) induced an increasing current in the secondary, and as by a mechanical device the galvanometer circuit was only closed a fraction of a second before the cut-out broke the circuit, the deflection of the galvanometer could be taken as an accurate proportional indication of the current strength.

The chief results obtained are tabulated below. The water resistance which formed part of the experimental apparatus was so arranged, that the maximum to which the current could rise was adjustable. Thus it was possible to adjust the current overload on the cut-out in three steps.

1. An overload not exceeding 50 per cent. of the current at which the cut-out was set to act.
2. An overload not exceeding 75 per cent.
3. As complete a short circuit as possible.

Five readings under each set of conditions were taken. The results in the table are the average of the five:—

Carbon Contact Cut-out.

| Current at which cut-out was set to act, and overload adjustment. (Amperes.) | | Current at moment of circuit being opened by cut-out. (Amperes.) | Time elapsing between closing of circuit and opening by cut-out. (Seconds.) |
|---|---|---|---|
| 15 | 50 per cent. | 22·61 | 0·1183 |
| | 75 " | 28·13 | 0 0918 |
| | Short. | 70 32 | 0 0737 |
| 20 | 50 per cent. | 29·08 | 0 1199 |
| | 75 " | 30·48 | 0·1000 |
| | Short. | 74·83 | 0·0413 |
| 25 | 50 per cent. | 34·02 | 0·0882 |
| | 75 " | 41·56 | 0·0599 |
| | Short. | 84·26 | 0 0465 |
| 30 | 50 per cent | 45·65 | 0·0875 |
| | 75 " | 45·73 | 0·0918 |
| | Short. | 81·57 | 0·0621 |
| 35 | 50 per cent. | 50 74 | 0·0898 |
| | 75 " | 57·91 | 0·0708 |
| | Short. | 71·31 | 0 0446 |
| 40 | 50 per cent. | 58·09 | 0·592 |
| | 75 " | 62 35 | 0·588 |
| | Short. | 71·77 | 0·455 |

Mercury Contact Cut out.

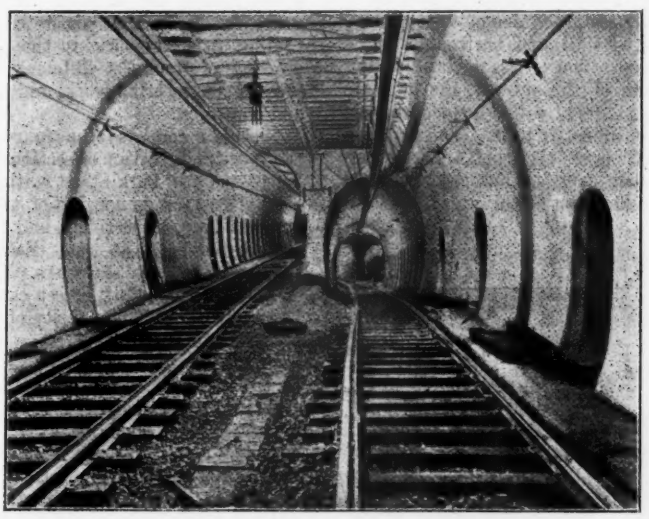
| | | | |
|---|---|---|---|
| 4 | 50 per cent. | 4·3191 | 0·1668 |
| | 75 " | 6·6754 | 0·0760 |
| | Short. | 48·41 | 0·0475 |
| 5 | 50 per cent. | 5 9546 | 0·4023 |
| | 75 " | 7 8376 | 0·8598 |
| | Short. | 59·67 | 0·0812 |
| 6 | 50 per cent. | 6·6675 | 0·3878 |
| | 75 " | 8·1943 | 0·1959 |
| | Short. | 59 74 | 0·0574 |
| 8 | 50 per cent. | 11·5111 | 0·2733 |
| | 75 " | 12·15 | 0·1368 |
| | Short. | 66 69 | 0 0718 |
| 10 | 50 per cent. | | 0·2883 |
| | 75 " | 14·76 | 0·1891 |
| | Short. | 61·28 | 0 0747 |
| 12 | 50 per cent. | 16·66 | 0·3051 |
| | 75 " | 19·41 | 0·2435 |
| | Short. | 62·27 | 0 0548 |

From the behaviour of these cut-outs in the experiments, Messrs. Clark and Macmullen are led to the conclusion that the carbon contact cut-out tested is preferable to the mercury contact.

The apparatus for measuring the time was ingenious and simple, and the times recorded should be accurate, but it is difficult to see why the time the cut-out took to act on short circuit should be 0·04 sec. when the instrument was set for 20 amperes, and 0·07 sec. when set for 15. Similar discrepancies are noticeable in the results of the mercury contact cut-out, namely, 0·0475 sec. when set at 4 amperes, and 0·0812 sec. when set at 5 amperes. No doubt these differences are due to "sticktion" in the instrument, and, after all, 3½ hundreds of a second is not an important interval of time. It may be said roughly that a short circuit has no sense of time or respect for cut-outs, and that it is more than probable that in practice most cut-outs would fuse or act, whatever their type or design, in very nearly the same time under conditions approaching a short circuit. It would be well for those who make laws to remember this when dealing with the question of subdivision, *au pied de la lettre*, in internal wiring.

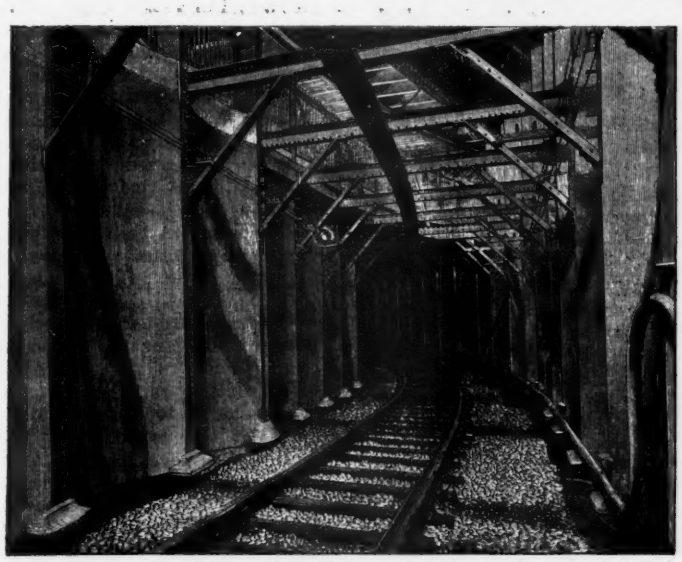
## THE BOSTON SUBWAY.*

Some years ago the horse-car system of the city of Boston was converted into a trolley system, and now the city is traversed in all directions by electric cars, and the combined routes of various companies serve almost the entire suburban district, as well as the city proper. After the introduction of the trolley, it soon became apparent that Boston required additional facilities for the transportation of street car passengers to the lower parts of the city. It was found that the problem of rapid transit was not solved by the trolley, owing to the overcrowding of traffic at certain points. The wholesale introduction of the trolley did not tend to improve the appearance of the handsome city, and the wires were particularly objectionable on Boylston and Tremont Streets, where they ran at the side of the Public Garden and the Common. The congestion of traffic on these two streets was very bad, and at times a solid line of cars made travel well nigh impossible.



Subway, Showing Crossing Tracks at Different Grades.

The problem was not one of providing rapid transit for a long distance, but of facilitating traffic upon certain existing and stated routes within a very small area, about 1 mile long, and ¼-mile wide. After a lengthy discussion of the matter, the Boston Transit Commission decided upon a subway system under certain streets, by means of which the electric cars would be diverted from the surface of the streets on some of the heaviest lines of travel, and would be run underground in a well drained, ventilated and lighted tunnel, which would, of course, be free from the objections to underground railways in which steam locomotives are used. Three of the 12 sections are now entirely completed, and cars are running through them, giving great relief to the overcrowded streets above.



South Bound Tremont Street Track Passing under Curve to Boylston Street.

The Subway Act was passed in July, 1894, by the Legislature of the Commonwealth of Massachusetts. There was a persistent fight made against it by an element of the community which was hostile to the construction of a subway. The friends of the subway were also obliged to contend with those who were hostile to it from a purely business point of view, and also against a public sentiment which wished for no encroachment on the sacred soil of the historic Common. The latter were extremely bitter in their antagonism to the subway plan; but at last the friends of the plan succeeded in stifling the opposition, and the Subway Act became a law. The opposition was soon after revived, and an injunction restraining the Commission from constructing the subway was refused by the Supreme Court, June 15th, 1896. The subway has been constructed under the direction of a Commission of five men appointed by the Governor and the Mayor, the Hon. George G. Crocker being the chairman. The completed work will cost something under $7,000,000.

Having now briefly referred to the plan as a whole, we will refer to details of construction. Many of the salient features of the subway have been described in the *Scientific American* for August 31st, 1895, and September 5th, 1896, and in the *Scientific American Supplement*, June 29th, 1895, No. 1,017.

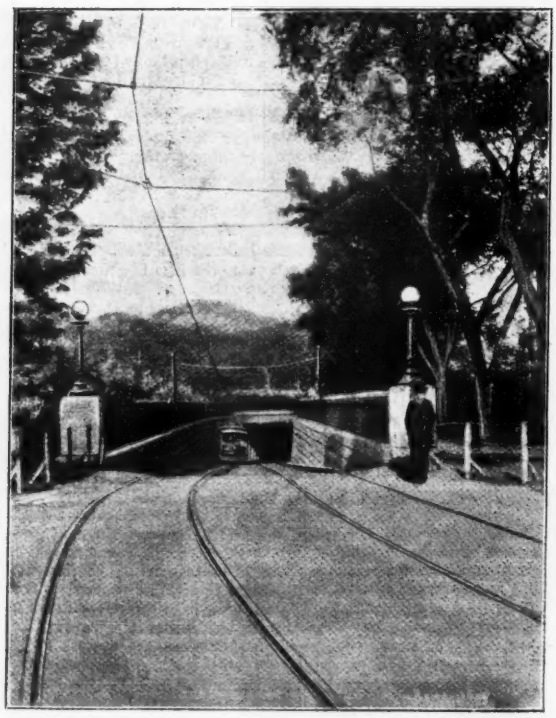
Sections 1, 2 and 3 consist of a two-track subway, commencing at the foot of the incline at the Public Garden, just west of Charles Street, and running under the Boylston Street Mall of the Common, at the intersection of Boylston and Tremont Streets, where the Boylston Street station is located. The four-track subway extends northerly from this station under the Tremont Street Mall to a point just below Temple Place, where the tracks separate to form the important Park Station, the two inner tracks forming the north and south bound tracks for the cars running to and from the Back Bay, Brookline, Brighton, &c. At the Park Street station the inner tracks terminate in a loop, which accommodates the cars which formerly ran to the old Tremont House, and then returned.

Sections 4 and 5, are nearly completed. The cars run up to Tremont Street to Warrenton Street, and then emerge from the subway by an incline, and run up Tremont Street and Shawmut Avenue respectively. For a short distance this is a four-track subway, but the four tracks run into two which pass through to Causeway Street in the northern part of the city.

The cars coming down from Boylston Street turn out of this street at Church Street and enter the subway in the Public Garden by an incline, which is shown in our engraving. The entrance to the incline is intended to be monumental in character, and mask it. The first section

* Abstract from *Scientific American*.

consists of 318 feet of incline, 685 feet of two-track subway, and, finally, 408 feet of four-track subway, the latter beginning at the Boylston Street station. The incline was illustrated in the *Scientific American* for September 8th, 1896, this engraving showing the retaining walls which were constructed upon concrete foundations. In this two-track subway, in order to avoid lateral pressure in the tunnel near the surface, the arch type of construction was not used, and the tunnel has been given a flat roof supported by brick arches turned between I-beams. The sides are of similar construction, the I-beams standing vertically. This establishes a number of arches both horizontal and vertical, each one of 6 feet chord. Diagonal struts connect the vertical and horizontal beams across the upper corners. Some attention was paid to draining this as well as the other parts of the subway, the concrete forming the side walls being plastered with Portland cement, and a coating of asphalte applied in turn to it. This asphalte waterproofing was continued over the roof. The pump chamber in the Public Garden contains automatic electric pumps by means of which leakage and rain water are discharged into the street sewer. A masonry ventilating chamber has been constructed near the Boylson Street station, and there are others at various points. They are supplied with 7 and 8 feet fans, to be driven by electric motors.



Entrance to Subway in Public Garden.

The four-track subway was made by an open excavation, and is 48 feet wide, the two-track subway being 24 feet wide. The middle row of steel columns support the roof of the four-track subway.

Section 2 really consists of the Bolyston Street station and its approaches. The station proper is 634 feet long, and consists of four tracks and two island platforms, each 30 feet wide. Entrance and exit is given to the Boylston Street station by four ornamental buildings of chiseled granite, which somewhat resemble the stations used in Buda-Pest for the underground railway. One of these is intended for north bound passengers, one for south bound passengers, and two for exit. The plan for receiving passengers at the subway stations has been a matter of careful study, the desire of the officials being to reduce to a minimum the possibilities of confusion incident to a heavy rush of passengers. In the place of the surface ticket office, there are set up at the foot of the stairways leading into the tunnel from each of the buildings three booths for the sale of tickets. As the passenger passes into the subway he will stop before one of these offices and obtain a ticket and receive a coupon, which he retains until the conductor of the car takes it up. Between the ticket offices are passages, each of which is wide enough to admit one person at a time. The subway platforms are of smooth artificial stone, and between the platforms are high barriers of netting designed to keep people from crossing from one track to the other. The interiors of the stations are as light as day, and are covered with enamelled brick, which reflects the light of an arc lamp. One of the engravings shows the south bound Tremont Street track passing under the curve to the Boylston Street track. This crossing of tracks at different levels is a very interesting piece of engineering work, and will tend to avoid accidents and confusion.

Section 3 consists of a four-track subway running from the four-track portion of section 1, which is north of Boylston Street and the Park Street station itself, which includes the loop. The station consists of two island platforms 250 and 275 feet long, respectively, and the platforms vary in width, the greatest being 40 feet. Each platform is connected with the street by two stairways. Loops are provided, so that cars running to Park Street can only be sent on the return journey without the necessity of switching. Tracks are also provided for holding street cars for the rush hours, and also tracks with pits for making temporary repairs. At the northern end of the Park Street station the two outside tracks, after passing around the loop, converge into two separate single track subways, which unite and go down Tremont Street towards Scollay Square. This part of the work is not completed as yet.

Sections 4 and 5, which are almost complete, consist of two two-track inclines, and the four and two-track subways run up Tremont Street to the Boylston Street station. It consists of two two-track inclines, a short length of two-track subways which finally run into two separate single track subways, one for the south bound cars at the lower level, 39 feet below the street at Boylston Street, while that of the north bound cars is only 22 feet below the surface. These two subways converge into a double barrel subway opposite the new Hotel Touraine, both being brought to the same level before reaching Eliot Street, where the two tracks are carried in a wide single arch subway. At Hollis Street the westerly track is depressed, and branches into another double bell mouth. One side is for the south bound Tremont Street cars, and the other for the south bound Shawmut Avenue cars, while the east barrel rises until it crosses over the south bound Shawmut Avenue subway to carry the north bound street cars without the necessity of crossing at grade. This represents a most interesting piece of engineering work, and the different grades of the tracks are well shown in our engraving, which shows the south bound track divided where the Shawmut Avenue cars pass under the north bound Tremont Street cars. This section of the subway is not quite completed as yet. Refuge niches will be seen in the side walls.

The track used throughout the subway is the Am. S. C. E. standard, weighing 85 lbs. to the yard, with continuous joints. Each rail is protected by a guard rail, weighing 45 lbs. to the yard. The rails are spiked to oak ties. The ties are laid on broken stone, and carefully ballasted with it. Each rail is connected by a copper bond. The ordinary overhead trolley system is used. An inverted wooden trough is fastened to the ironwork of the roof, and insulated with sheet rubber. The trolley wire is supported by special bolts and clips, which are insulated. The system used does not differ much from that used in Brooklyn, where the wires are suspended from the elevated structure. At present the current is taken from the underground feeder, but direct cables to the power station for supplying current to the subway alone will be added. It will be noticed that the subway is a direct continuation of the surface trolley lines, no change being made in either the motive power or the method of furnishing the current to the cars.

The subway is lighted throughout by both incandescent and arc lamps. In the portion now in operation, 600 incandescent and 55 arc lights are used. The arc lights are used for lighting the stations. The system of electric block signals is in process of installation, and electric heaters are located in the ticket offices.

The chief engineer is Mr. Howard A. Carson. The Boston Transit Commissioners are: George G. Crocker, chairman; Charles H. Dalton, Thomas J. Gargan, George F. Swain, Horace G. Allen.

## CORRESPONDENCE.

### Re Donaldson's Gas Engine.

I shall not enter into a discussion with Mr. Butler on the scientific aspects of the gas engine question. They have already been thoroughly thrashed out. Either Mr. Butler has been imitating Rip Van Winkle, or he deliberately rejects the conclusions arrived at by the recognised authorities on the subject. They have unanimously come to the conclusion that an increase in the efficiency can only be obtained by an increase in the explosive pressure, and that this can only be attained by an effective clearance out of the waste gases and instantaneous explosion, and that this last can only be attained by a perfect mixture of the gases before ignition. I claim by my two inventions to have completely effected these two objects. The 200 lbs. explosive pressure, which Mr. Butler describes as the ordinary pressure, has long ceased to be even an approach to the ordinary pressure in the best class gas engines.

I cannot, however, pass over his comments on the originality, or want of originality, of my inventions. None of the cases cited by him either anticipate my inventions or interfere with my patent rights. With the exception of the Acme, all the inventions cited so far as the second piston and compounding are concerned, have been anticipated by Otto's patent for a single cylinder engine provided with two pistons, one making half the number of revolutions of the other, the object being to effect a complete clearance of the gases, and by Daimler's patent for a combination of two explosive cylinders each provided *with one piston* and a single expansion cylinder. Steny and Hogg engines must be almost identical with Otto's engine, in which the mechanical arrangements for working the two pistons are practically unworkable. It is barely three years since I devoted my attention to gas engine construction, and I was not aware till your issue this morning that the Acme was a compound two-cylinder engine. There is, however, this important difference between the two cases. The inventor of the Acme engine adopted a second shaft running at half the speed of the first shaft in order that he might use in a proper way an expansion cylinder in conjunction with a single explosion cylinder working on the Otto cycle. I adopted the combination because I had already a second shaft running at half-speed for another purpose. I should not, however, in practice, ever adopt a two-cylinder compound engine for two reasons:—(1.) Because the cost of a three-cylinder engine constructed in accordance with my patents would not exceed the cost of a two-cylinder engine by more than 20 per cent., whilst its power would be more than double that of a two-cylinder engine. (2.) Because, in the case of a two-cylinder compound engine, the piston in the expansion cylinder will be at mid-stroke when the piston of the explosive cylinder has reached the end of the exhaust stroke, so that the gases left in the explosive cylinder must be subject to at least 40 lbs. absolute pressure. The volume of waste gases left in, when subject, after expansion to atmospheric pressure, will therefore be at least double the volume left in at the end of the exhaust stroke. In the case of my compound gas engines, the volume left in at atmospheric pressure varies from about $\frac{1}{2\frac{1}{2}}$th the volume of the charge in the case of a three-cylinder engine to about $\frac{1}{1\frac{1}{2}}$th in the case of a two-cylinder engine. In the case of the Acme with a single piston in the explosive cylinder, if the compressed volume is equal to $\frac{1}{3}$th the volume of the charge, a voluminal compression, which corresponds with an initial compression pressure of over 100 lbs. ind., the volume of the waste gases left in would, at atmospheric pressure, be equal to about one-half the volume of the charge. If the compressed volume is equal to one-third the volume of the charge which would correspond to at least 50 lbs. initial indicated pressure, and to about Mr. Butler's ordinary explosive pressure of about 200 lbs., the volume of waste gas left in would be equal to about two-thirds the volume of the charge. In the case of the single cylinder engine working on the Otto cycle, there is only one working stroke for every two revolutions; of the two cylinder engine, one working stroke for each revolution; and, in the case of the three cylinder engine, two working strokes for each revolution. With a fly-wheel, therefore, suitable in the case of a single cylinder for running at maximum speed, the rate of speed may be very much reduced—certainly to at least one-third the maximum speed—without affecting the steady working of the engine. We may therefore reduce the amount of work done in a given time to less than one-third of the maximum work which the engine is capable of giving out without impairing the efficiency. In the case of a single cylinder engine the speed cannot be varied, and it is found in practice that the greater the variation of the work actually done from the maximum the engine is capable of doing, the greater is the loss of efficiency.

After my application for the English patent, I applied for the U.S.A. and German patents, but did not hear from either office until after I had been compelled to complete my English patent. Both U.S.A. and the German patent offices cited the same patents against me on the points raised on Mr. Butler's letter, viz, the patents of Otto and Daimler. The German office granted my claims for the means of varying the volume of the waste gases left in the cylinder and the initial pressure, but nothing more. The German office grant claims for ideas, not for the special mechanical appliances necessary to carry them out successfully. The U.S.A. Patent Office has granted me five out of the seven claims I made.

The claims granted protect

(1). The special mechanism for actuating the two pistons of a single cylinder engine.

(2). The combination of two explosive cylinders, each provided *with two pistons*, and a single expansion cylinder.

(3). The mechanism protected by the claims granted by the German Patent Office.

**William Donaldson.**

### Electricity Supply Centralisation.

The thanks of electricity supply engineers, and especially those connected with municipalities, are due to Mr. Wright for his carefully thought out paper appearing in your columns this week. The importance of the subject at the present time cannot easily be over-estimated, and this must be my apology for taking up your space with this letter, as one feels, after reading the paper and your pertinent leader thereon, that an unassailable case for centralisation has been made out. Whilst agreeing with Mr. Wright as to the desirability of a General Purposes Electricity Committee, I venture to think that the sub-committees might be divided more radically. This might be done by grouping together production and distribution as being in "electrical connection" and having a separate Joint Tariff and Finance Sub-Committee. Besides these, there would, of course, be the Electric *Supply* Sub-Committee, for dealing with general consumers, the Tramways Sub-Committee, for conducting the details of its business with the travelling public. These are, however, matters which it is perhaps premature to discuss at the present moment. The really important points which cannot be too strongly urged now are the necessity, in the interest of the ratepayers, of centralising the whole of the electricity supply, and the adoption of a differential tariff for dealing with all customers on their merits, thereby avoiding any imputation of unfairness and doing the best for both buyer and seller.

**Harold W. Couzens.**

I think that Mr. Wright's article on the "Centralisation of Electricity Supply for Lighting, Power, Tramways, and General Purposes," which appeared in your issue for September 24th, has been brought forward at a most opportune moment.

In addition to the towns mentioned by Mr. Wright, and since his article was written, there must be added to the list the City of Bradford, which has just decided to equip and work about three miles of electric tramway (overhead system). The power for this purpose will be supplied by the Electricity Committee to the Tramway Committee, just as if the latter were a private company or consumer.

As the application of electricity to general purposes becomes more widely adopted, no doubt the corporation will see the necessity and advisability of forming a General Purposes Electricity Committee, whose function and sphere would be to consider reports and recommendations from its sub-committees as Mr. Wright suggests. I concur with him that this is the only economic and satisfactory method of dealing with the various phases of electricity supply from a municipal point of view, and in addition such an arrangement would obviate the unreasonable jealousy with which the Chairmen of different committees at present resent any interference with their especial duties by other departments.

Upon this question of the economics of municipal enterprise as applied to electricity supply, one may go a step further and see therein the dawning of the natural solution of the problem of the best system and method of generation and distribution.

With regard to electric tramways, I think the power supplied will ultimately be infinitely small in comparison with that required for private industrial purposes. In respect of the former, I endeavoured to show in an article in the *Railway World* for April and May last, how the cost of energy may be economised with the use of certain forms and types of plant.

With regard to the application of electricity in Bradford for industrial power purposes alone, I may mention that we have a demand for 642 horse-power in motors on the mains of the supply. This amount is, therefore, already more than equivalent to the H.P. of all the existing tramcars, of which there are about 42 running at one time.

**Alfred H. Gibbings.**

Bradford.

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The situation at Glasgow, which is the text for Mr. Wright's able article in your last issue, is one of great moment and interest to municipalities generally. From the importance of that city, there is no doubt that the ultimate decision there will largely influence smaller corporations who may be considering combined schemes of lighting and traction. It is, therefore, to be hoped that the matter will be fully discussed, and all the pros and cons most carefully weighed before a conclusion is arrived at.

To my mind the duties of the Electricity and Tramways Committees are sharply defined, and there is no need for the slightest clashing of interests. The Electricity Committee should generate and distribute all current which may be required, and consider the Tramways Committee exactly as an ordinary customer. The Electricity Committee should deliver current right into the overhead wires of the trams just as though they were the house wires of the private consumers. The tramway feeders would be laid and maintained by the Electricity Committee, and so all underground street work would be kept in the hands of one department. The overhead equipment and the posts would be erected to the design and arrangement of the corporation electrical engineer, but paid for and controlled by the Tramways Committee. By making the same official responsible for this, as for the street lighting, the posts would be arranged with a view to both services, and the town, as a whole, would benefit. Such posts as were used by both the Tramways and the Street Lighting Committees would be paid for partly by each.

The Tramways Committee would attend to the construction of the track, the supply of motor cars, the arrangement of the routes, fares, and services, and would pay the Electricity Committee for all current consumed.

As to the price to be paid for current, there ought to be no difficulty whatever in arranging this. As Mr. Wright points out, the Brighton system of a sliding scale based upon the maximum demand, is as applicable to tramways as to lighting, and in his article he goes fully into the matter. I do not, however, quite see the fairness of lowering the initial price to the tramways. It is true that there is a smaller system of mains, very few meters, only one account to collect, &c., but if these are to be taken into account, we ought in justice to differentiate between large and small lighting customers. A small consumer a mile from the works costs as much to connect as a large consumer close to, yet we charge them both the same initial price.

I think all classes of consumers, private lighting, private motive power, public street lighting (arc or incandescent) and public tramways, should be all thrown together, and the charges based upon the combined output. When a reduction of the initial charge is to be made, the period for which it is charged should be lessened, rather than the price itself reduced, and when a reduction of any kind is made, it should affect all classes of consumers.

The tramway department could not then complain that its receipts were being bled for the sake of the lighting, nor the lighting customer that the tram fares were being lessened at his expense.

**John H. Rider.**

Plymouth, *September 28th*, 1897.

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Mr. Wright's admirable article on the above subject, in last week's Electrical Review, is well worth a brief note of commendation from all those who have carefully studied the matter; and I therefore hasten to add my contribution to the others which you have doubtless already received.

In dealing with this topic as it has been raised at Glasgow by an agitation for combining into one the separate Corporation Electricity Supply and the Tramways Committees, Mr. Wright's article falls naturally into three divisions, which are, perhaps, worthy of being pointed out with more emphasis than has been done. In the first place, he discusses with some amount of adverse criticism the proposal put forward by the Lord Provost of Glasgow in regard to such an amalgamation as that in question, and shows its want of logical completeness as well as its doubtful policy; but since the author explicitly disclaimed perfection for it, and only offered it as a suggestion to be improved upon, perhaps no great amount of further criticism is required.

In the second place, Mr. Wright gives his own counter proposal for the establishment under like conditions of a "General Purposes Electricity Committee," with various sub-committees for special objects.

The improvement in his arrangement is very clear. Adopting the suggestion of the Glasgow authorities, the chief committee would be r too much of a mixture of maker and customer; and, as Mr. Wright remarks, it is better to let the chief committee deal with the question of supply and distribution of electrical energy only, irrespective of the consumer, who may be a private person, a company, or even a separate municipal department.

Mr. Wright's proposed arrangement is, therefore, to my mind, by far the most logical and the least productive of unnecessary friction between parties; and I think it would be difficult to offer any better suggestion for the proper supply of energy by a local authority. The control and regulation of any public lighting would, in such a case, fall into the hands of a separate lighting committee, and no possible question need then arise as to the fairness of the same committee making and selling electricity to itself for public lighting purposes. If a joint tramway and electricity supply committee were formed, it would (to be logically complete) also need to embrace the other municipal departments which either now, or in the early future, may become customers for electricity, in which case the electricity committeemen would take first rank as Lords High Everything—a picture of municipal progress not easy to have foreseen a few years ago.

The third section of Mr. Wright's article is one that deals with the question that he has, perhaps, nearest to his heart, and which at any rate he is extremely well qualified to discuss, viz., the cost of supply, and consequently the charges which are, or ought to be made, for electricity from a municipal station for tramway purposes.

At present, the arrangements made in this respect appear to vary very much, partly because conditions have been different in each case, but largely because the respective parties didn't quite know where they stood.

Mr. Wright mentions, as a fair average rate, 1½d. per unit for tramway purposes, and the foundations for his statement appear to be substantial. The Blackburn Corporation agreed to sell current at about this rate to the tramway company, but at Dover the electricity supply company gets a much bigger price from the Corporation tramways. In both cases it appears likely that the company (as compared with the local authority) got the best of it; at any rate the Blackburn Corporation has bought up the tramways, though the Dover municipality shows no signs as yet of buying back the electricity supply business.

There is no doubt that the relative adjustment of price for tramway current will require as much care as that for lighting, when supply is from a common source, for obviously it will not be fair for one department to benefit at the expense of another.

The tramway authority—whether a company or municipal department—as a matter of fact will find it absolutely essential to its reasonable existence that an excessive price shall not be charged for electricity; for as has already been pointed out in your columns, the conditions of tramway service are in comparison much more onerous than those of lighting. For the latter purpose current is for the most part only used when actually required by the consumer, and nearly the whole of the load is productive. But with tramways the service (though involving a load diagram of greater squareness on the whole) must be maintained to a large extent, whether productive or not.

Tramway managers, therefore, may well demand careful consideration of the subject from every point of view before definite arrangements are made as to supply of current, and the charges for same. Moreover, not only should the maximum demand for current be carefully ascertained, and the fairest rate arrived at, but also if carried to a logical conclusion, varying fares ought to be levied, so that those who use the tramways most often may benefit by a corresponding "maximum demand" rate for transit.

Tramways like those at Glasgow have to buy current and sell rapid transit; and those in command need to make sure of their figures on both sides before fixing them for any length of time. As a considerable step forward in the former direction, I therefore welcome Mr. Wright's expression of his views, which deserve very great and serious consideration.

Frank B. Lea.

## THE ENGINEERS' STRIKE.

As week after week continues, the fact becomes more and more apparent that so far as manufacturing establishments are concerned, the question of eight hours is held of less account by the masters than are the foolish and absurd regulations set up by the Trades' Unions in respect of the "one machine, one man," idea, and that man a fully-paid member of the Union, who, on the face of it, ought to feel ashamed to accept pay for doing labourers' work, when he is supposed to be capable of doing skilled work. There is about as much skill in working many machine tools on repetition work as there is in pushing a lawn mower, or turning the handle of an apple parer. Indeed, more skill is needed to work a sewing machine than is needed on many repetition tools. The way the men grumble is a bit ludicrous. A young engineer writes to the *Daily Telegraph* that whereas he has often taken home £4 to £5 a week, he now receives 12s. a week strike pay. He has the remedy in his own hands. He has chosen to follow the orders of his officials, and grumbles that it is costing him a comfortable living. Surely a man earning so much would do far better to insure in some reputable life or accident office, which does not spend accumulated funds in pitched battles with its fund providers.

Mr. Mather is, we think, right in his assumption that the masters attach more importance to the question of restrictions than to that of eight hours, but the Federation declare that eight hours spells ruin. We fear it does to the firms who are not in what we call the repetition trade, or, as some call it, engaged on standard lines. In a shop doing special work and repair jobs, eight hours will not pay. Customers simply refuse to pay bills, because, as they put it, "your eight hours' day is nothing to us," and "we will not pay extra for overtime, even though we asked you to work it for us." We know of work now carried out by special request by day and night for which payment is withheld, because the cost comes out unexpectedly heavy, and the foregoing excuse is made. Here an eight hours' firm must either suffer loss, or endeavour to gain their just demand by a lawsuit. All this is against the eight hours, and while we consider that the men are under an error in supposing that the masters wish to smash the Union, every day's additional experience convinces us that the A.S.E., as worked, has become worse than useless, and is likely to smash itself in the present conflict, even if it were victorious, for reasons we have previously given.

As regards the difference between a manufacturing and a general engineering shop, we are convinced that it is upon the latter that the shorter hours will most heavily bear. Where men are taking home £3 to £5 per week, it is obvious that the charges for repairs must be increasingly difficult to levy upon customers. Men working away from the shop do a surprisingly small amount of work, and contrive to put in such enormous claims for lodging out fee, that work is becoming positively prohibitive. It is impossible to discuss with the men the question of foreign competition, they simply will not discuss it. They appear to think that they are being asked to lower themselves to the level of the foreigner, yet they cannot see that they are being ousted both by the cheaper German on one side and the dearer American on the other. The German works for less money, while the American puts no obstacles in the way of machinery, or in the way of one man looking after many machines. Between the two, the Trades Unionist of this country will come to grief.

The use of labour-saving machinery to its full extent has, in America—we quote the *Times*—reduced the wages per unit of output by 25 per cent. Probably the best paid men in America are the machine shop men. In other trades, where less labour-saving machinery is employed, wages are not so good, and for the labour of the collier, for example, life is reported as a bare existence, and the American miner is but a mere slave. It is the use of machinery to the fullest extent that has improved the machine works. But to our own Trades' Union men a lathe 50 years' old is as good as one made yesterday, for the simple reason that your unionist won't run a lathe on a big cut, or at full speed, and so gets nothing extra out of a new and heavy tool. We cannot be surprised that the employers will have no more of this. Some are fighting to win, others have stopped their works, we doubt not, finally; others have gone back to nine hours. All are convinced that profitable working cannot be secured while the works are managed from Stamford Street.

John Burns has written a long letter to the *Times* begging the whole question. For example, he quotes Germany's small shipping output in 1896, but omits to say that Germany has increased to this output of 81,000 tons in a very short time, nor does he say that the biggest ship afloat is German built. John Burns begs the question of American overtime also. He states it is on the same lines as here, but this is not so. In America overtime does not commence until 10 hours have been worked. John Burns wants English ovartime to begin at the increased rate from eight hours, so that in 10 hours the English employer has paid 10½ hours' wages against the American 10 hours. He makes a charge of wooden headedness against English employers in regard to new and improved methods and tools, but he omits to state that the Trades' Unions have been ever the block in the way, and are responsible for checking the use of improved plant.

We hear a good deal about grinding the faces of the poor, but probably agitators have done more to grind the faces of the poor in the last 10 years than all the engineering employers in England have done for 50 years past. And this time no one had any grievance, and the men have simply sold their birthright of freedom to give to a handful of agitators their mess of pottage.

## ELECTROLYSED SEA WATER.

We mentioned in a note last week that the experiment of the Bombay Corporation as to the utility of electrolysed sea water for sewer cleansing had been unfavourable. We are now able to give a copy of the report on the subject, which was prepared by Mr. B. H. Hewett, assistant engineer of the mechanical branch of the Bombay Corporation. In requesting Mr. Hewett to inquire into this subject, the Corporation asked for a report "as to the utility of the electrolysed water for cleansing any considerable length of sewers, and to what distance its effects are noticeable; also if useless for this purpose, how the product can best be utilised." His statement is as follows:—

When the electrolysing plant was first started on May 14th, the whole of the fluid was run into the night-soil tanks with the flushing water. Its use did not minimise to any appreciable extent the very strong fœcal odour given off at the time the night-soil carts were being actually emptied into the tanks, but the smell in and around the depôt disappeared much more quickly with the fluid than without it after the carts had been discharged. The walls and floors of the tanks were also kept very much cleaner than before, and the considerable colony of maggots inside were, I believe, all killed. This was reported to me by the men who go into the tanks to brush them out, and they were needlessly alarmed on this account because they thought that the fluid must be very poisonous, and would do them some injury. After the plant had been at work for a short time, Mr. Cooper asked that the fluid might be passed direct into the main sewer without first running through the tanks, and this was accordingly done by making a connection into the branch sewer from the tanks.

As long as the fluid was running this branch was perfectly free from smell, but considering that during the daytime there was practically nothing besides the fluid running through it, the results could not be said to be very startling. The results after the fluid had passed from the branch sewer into the main sewer were not perceptible. This I attribute, first, to the fact that the sewage running into the main sewer past the depôt was always very highly diluted, and therefore free from smell; and, second, that there was such a large volume passing, that it was hardly possible for the fluid to effect any change. Observations taken on June 3rd by the Drainage Department staff showed that between the manhole opposite Dongri Street and the one opposite Mandvi Street the sewage was flowing through

the sewers at the rate of 550 cubic feet, or 3,437·5 gallons per minute.

The maximum producing capacity of the electrolysers is 2,000 grammes of chlorine per hour, so that the sewage was being mixed in the proportion of 1 gramme (about $\frac{1}{28}$th part of an ounce) to 103 gallons of sewage. With such a very minute admixture of chlorine, it is impossible to obtain any results, and the fluid used in the above manner was simply wasted. As a matter of fact, samples of sewage taken at next manhole beyond the point of inlet of the fluid did not show the slightest trace of chlorine, and these samples and other samples taken from the manhole behind the point of inlet kept practically an equal length of time before developing any offensive smell.

The patentees claim that 5 grammes of chlorine per head of population per 24 hours is sufficient for deodorisation in a temperate climate, and allowing for a maximum water supply of 40 gallons per head, this would give 1 gramme of chlorine to eight gallons of sewage. When the plan is re-started, at the beginning of October, I would propose that experiments should be conducted on the following lines:—

1. To see whether, with a liberal use of fluid through the night-soil tanks, and its use for washing out the carts after they have been emptied, any appreciable reduction is made in the nuisance arising from the depôt.

2. Whether by carting the fluid away in flushing carts, drums, &c., it could be profitably used by the Health Department in place of phenyle and carbolic powder, &c., for flushing gullies.

3. Whether public institutions, such as hospitals, would make regular purchases of the fluid for washing floors, clothing, &c.

The cost of producing the fluid is an important item, and it will perhaps be not going beyond the scope of the Commissioner's inquiries if I give the working expenses up to date. The total number of days the plant was at work during May and June was 34, and it may be estimated that, after deducting time for cleaning fires, oiling, &c., 22,000 grammes of chlorine were produced per day, 22,000 grammes × 34 days = 748,000 grammes, or, say, 15 cwts., total production, at a cost of Rs. 1,039 6-1 for working expenses. Good commercial chloride of lime, containing from 30 to 35 per cent. of free chlorine, may be purchased in Bombay for about Rs. 260 per ton, which would bring the actual cost of chlorine to, say, Rs. 780 per ton. The comparative cost is therefore as follows:—Chlorine produced by electrolyser, cost per ton Rs. 1,386. Chlorine obtained from chloride of lime, cost per ton Rs. 780. This is not favourable to the electrolytic process, and the cost would be further enhanced if interest on capital expenditure were added. It is, however, rather too soon to make any strict comparisons, as the cost of starting a new plant is always comparatively heavy, and a considerable additional expenditure has been incurred by hire of pumping engine and extra staff for the same for pumping up sea-water. The plant will be at work continuously from October to the end of the financial year under favourable conditions as regards water supply; and these five months' work will give a reliable basis on which to work out the cost of production. If the cost of producing chlorine by this process is not considerably less than the rate at which it can be locally purchased, the results will be disappointing. I say "less" advisedly, on account of the extra cost that would be incurred in transporting the fluid, owing to the large bulk of sea water which is used as the base.

B. H. Hewett,
*Assistant Engineer, Mechanical Branch.*

Mr. James W. Smith, M.Inst.C.E., deputy executive engineer, drainage, says:—If Mr. Hewett has any bias at all, it is in favour of the system, inasmuch as he advocated the purchase of the installation, and therefore there can be no adventitious gloss to allow for by the way of reducing the condemnatory effect of his report. It will be seen that the effect on the sewer was *nil*. The most disappointing point in the report is that the electrolysing process is not a cheap means of producing chlorine, and in estimating the cost, Mr. Hewett makes no allowance for the outlay on the electrolysing plant, the wear and tear of the portable engine at the night-soil depôt, and the use of the suction pipe, the engine house, and the tanks; nor does he consider the cost of pumping at Love Grove, the (to use his own words) "large bulk of sea water which is used as the base," *i.e.*, of the chlorine.

Mr. M. C. Murzban, Executive Engineer, says he agrees with the views expressed by Mr. Smith in his letter under reference. So far as can be seen at present, the electrolysing is not likely to prove a success financially.

Mr. P. C. H Snow, Commissioner, recommends the suggestions of Mr. Hewett being carried out, and the plant worked up to the end of the financial year, after which, unless more favourable results are obtained, the experiment can be abandoned.

## BUSINESS NOTICES, &c.

**Bankruptcy Proceedings.**—George Thompson, trading as G. Thompson & Co., of 115, Queen's Road, Brighton, electrical engineer, was publicly examined by the Official Receiver at the Brighton Bankruptcy Court last week.

**Liquidation Notices.**—A meeting of the *old* Callender Company (Callender's Bitumen Telegraph and Waterproof Company, Limited) will be held on October 27th at 90, Cannon Street, E.C., for the purpose of hearing an account of the winding up of that company. It will be remembered that the present Callender's Cable and Construction Company took over the business of the old company.

## Electrical Wares Exported.

| Week Ending Sept. 28th, 1896 | £ | s. |
|---|---|---|
| Alexandria ... ... | 50 | 0 |
| „ Teleg. mat. | 140 | 0 |
| „ Teleg. wire | 264 | 0 |
| Antigua ... ... ... | 10 | 0 |
| Antwerp ... ... | 21 | 0 |
| Bangkok ... ... | 300 | 0 |
| Bombay ... ... ... | 455 | 0 |
| „ Teleph. mat. ... | 38 | 0 |
| Brussels ... ... ... | 602 | 0 |
| Buenos Ayres ... ... | 216 | 0 |
| „ Teleg. mat. | 188 | 0 |
| Calcutta ... ... ... | 247 | 0 |
| Cape Town ... ... | 288 | 0 |
| „ Teleg. mat. | 4,550 | 0 |
| Delagoa Bay ... ... | 15 | 0 |
| Durban ... ... ... | 155 | 0 |
| Flushing ... ... | 9 | 0 |
| Gothenburg Teleg. wire | 192 | 0 |
| Jersey. Teleg. mat. ... | 18 | 0 |
| Launceston ... ... | 870 | 0 |
| Leghorn ... ... ... | 100 | 0 |
| Lisbon. Teleg. mat. ... | 11 | 0 |
| Madras ... ... ... | 204 | 0 |
| Malta. Teleg. mat. ... | 64 | 0 |
| Marionpol ... ... | 2,147 | 0 |
| Mollendo ... ... | 14 | 0 |
| Otago ... ... ... | 17 | 0 |
| Perim. Teleg. mat. ... | 102 | 0 |
| Port Elizabeth ... ... | 461 | 0 |
| Rangoon ... ... | 10 | 0 |
| Rotterdam ... ... | 55 | 0 |
| St. Petersburg ... ... | 252 | 0 |
| Shanghai. Teleph. mat. | 37 | 0 |
| Singapore ... ... | 19 | 0 |
| Stockholm. Teleg. mat. | 155 | 0 |
| Sydney ... ... ... | 495 | 0 |
| Trinidad ... ... | 8 | 0 |
| Wellington ... ... | 129 | 0 |
| „ Sub. cable | 4,300 | 0 |
| Yokohama ... ... | 110 | 0 |
| Total | £17,318 | 0 |

| Week Ending Sept. 28th, 1897. | £ | s. |
|---|---|---|
| Alexandria ... ... | 70 | 0 |
| Amsterdam ... ... | 50 | 0 |
| Antwerp. Elec. fuses | 124 | 0 |
| Beira ... ... ... | 528 | 0 |
| „ Teleg. mat. ... | 1,060 | 0 |
| Bombay ... ... ... | 14 | 0 |
| Brussels. Teleg. mat. | 27 | 0 |
| Buenos Ayres ... ... | 202 | 0 |
| Calcutta ... ... ... | 475 | 0 |
| Cape Town ... ... | 261 | 0 |
| Chenai ... ... ... | 8 | 0 |
| Christchurch ... ... | 9 | 0 |
| Christiana ... ... | 9 | 0 |
| Durban ... .. ... | 30 | 0 |
| East London ... ... | 49 | 0 |
| Fremantle ... ... | 458 | 0 |
| Gothenburg ... ... | 1,334 | 0 |
| Hong Kong ... ... | 7 | 0 |
| Jamaica ... ... ... | 74 | 0 |
| Lisbon ... ... ... | 10 | 0 |
| Lyttleton ... ... | 25 | 0 |
| Madras ... ... ... | 9 | 0 |
| Marionpol ... ... | 435 | 0 |
| Melbourne ... ... | 75 | 0 |
| „ Teleg. mat. | 1,402 | 6 |
| Port Elizabeth ... ... | 64 | 0 |
| Rosario ... ... ... | 290 | 0 |
| „ Teleg. cable ... | 558 | 0 |
| St. Petersburg. Teleg. wire | 69 | 0 |
| Santos. Teleg. mat. ... | 18 | 0 |
| Shanghai ... ... | 199 | 0 |
| Singapore. Teleph. mat. | 74 | 0 |
| Stockholm. Teleg. wire | 188 | 0 |
| Trinidad ... ... | 25 | 0 |
| Vigo. Teleg. cable ... | 7,000 | 0 |
| Wellington ... ... | 396 | 0 |
| „ Teleg. mat. | 90 | 0 |
| Yokohama ... ... | 384 | 0 |
| Total | £16,119 | 0 |

**Auction Sale.**—Messrs. Percy Huddleston & Co. will offer for sale, by public auction, on Thursday, October 7th, the stock of an electrical engineer and contractor, at 16, Long Millgate, Manchester, comprising dynamos, motors, lamps, switches, and a variety of fittings and sundry accessories. See our "Official Notices" of last week for further details.

**Books Received.**—"Lectures on Physiology. First Series—on Animal Electricity." By Dr. Augustus D. Waller. Published by Longmans, Green & Co. Price, 5s.

"Record of Transactions of the Institution of Junior Engineers, 1895-1896." Vol. vi.

"Electricity in the Service of Man," by R. Wormell and Dr. Mullineux Walmsley. New edition. Cassell & Co.

**Change of Address.**—Messrs. J. Goolman & Co. inform us that they are removing from to-day's date to larger premises, at 48, Commercial Street, E.

**Correction.**—Messrs. Julius Sax & Co. write as follows: "We observe a paragraph in your issue of the 24th inst. to the effect that a new company, under the title of 'Sax, Slatter & Co., Ltd.,' has been formed to take over the business formerly carried on under the style of 'Julius Sax & Co., Ltd.,' at Forester's Hall, Clerkenwell Road, E.C. As this notification may possibly lead persons to assume that 'Julius Sax & Co., Ltd.,' have parted with their business, we write to inform you that this is not the case, and that 'Sax, Slatter & Co., Ltd.,' have no connection with 'Julius Sax & Co., Ltd.' The business formerly carried on at Forester's Hall by 'Julius Sax & Co., Ltd.,' being of an entirely different nature to their ordinary business, was recently discontinued. 'Julius Sax & Co., Ltd.,' still continue to carry on the business of electrical engineers and electric light contractors, at their works, 119, Coldharbour Lane, Camberwell, S.E., where they continue to manufacture in addition to all ordinary electrical appliances, their well-known telegraphic and telephonic instruments, patent fire and burglar alarms, &c. The business has recently been placed under new management, and the company is at present actively engaged in executing contracts of considerable importance."

**Enclosed Globe Arc Lamp.**—Messrs. Beanland, Perkin and Co., of Leeds, are introducing on to the English market the "Improved Ajax" enclosed globe arc lamp. In this lamp the customary clutch feed is superseded by a double rack system, which is claimed to give better results, especially where lamps are exposed to jar or vibration. The mechanism and cases are entirely disconnected from the electrical circuit, and there are stated to be no loose joints or sliding contacts. These lamps are always furnished with "Holophane" light-diffusing globes, either outer or inner, the result being that the amount of light emitted is practically doubled. It is claimed that the lamps are therefore particularly suitable for street lighting, but some special Flemish and Rococo designs are made for the best class of interior work.

**European Branch.**—The Columbia Phonograph Company, of New York, announce that they have established a display room and warehouse in Paris, 34, Boulevard des Italiens, in charge of Mr. Frank Dorian, for many years general manager of this company. All communications should be addressed there.

**Fires.**—A Glasgow paper says that on 26th ult. the wires fused of an electrically blown organ in a private residence at Lynedoch Place, Edinburgh, a fire resulting.

A fire, caused by a short circuit of electric wires, broke out at Messrs. Liberty & Co.'s premises in Argyll Place, Regent Street, W., on Tuesday.

**From the Consular Reports.**—Consul-General Schwabach, in a report to the Foreign Office on the trade of Berlin in 1896, says:—"An increasing demand for copper may be expected, as in Germany a great impetus has been given to the use of electricity for industrial purposes, and for traffic electric cars."

Consul Cocoto, in a report on the trade of Brindisi, says:—"The illumination of that city by electricity has been further extended, the seaport of the town having now a row of 12 powerful arc lamps. Shipmasters approaching or passing Brindisi at night time have now no difficulty in ascertaining the position of the town, the flare being so noticeable."

Consul Vecqueray, in his annual report on the trade of Cadiz, says:—"In Cordoba there are two electric lighting companies, one with a steam factory, and the other having both steam and water-power factories. All the principal towns in the province are rapidly introducing this luxury, making use, where possible, of water-power."

Mr. Vice-Consul E. Diaz, of Huelva, reports that "that town has been lighted with gas since about 1880, from works erected by a Glasgow company, by the Huelva Gas Company, whose coal, machinery, and plant are brought from Great Britain. This company, which is now called the Huelva Gas and Electric Light Company, has begun the installation of the electric light, the main wires of which are already put up through the town. It is not yet certain when the work will be sufficiently advanced to serve the light to the public."

Consul Sir James Harris, in his annual report on the trade of Nice, says:—"The existing methods of propelling the tramcars on the Nice Cimiez Electric Tramway, *i.e.*, by means of stored electricity, not having proved suitable to the nature of the line, owing to its steep gradients, the Nice Municipal Council has recently authorised the present company to alter its system of traction to the overhead trolley system."

Consul Gould, in his report on the trade of Port Said during 1896, says:—"The percentage of ships passing through the Suez Canal, using the electric light, has been as follows:—1890, 83 per cent.; 1891, 88 per cent.; 1892, 90 per cent.; 1893, 92 per cent.; 1894, 94 per cent.; 1895, 95 per cent.; 1896, 94 per cent."

Mr. Vice-Consul Wardrop, in his annual report on the trade of Kertch (Russia), says:—"An attempt has been made on a small scale to use an electric current to quicken the growth of agricultural products. A few miles from the town a piece of land has been planted with telegraph poles, and interlaced with wires, but frequent inspection has failed to reveal any sign of exceptional fertility."

In his annual report on the trade of Santiago de Cuba in 1896, Consul Ramsden says:—"A private company is putting up a small electric light plant, for the purpose of furnishing incandescent lights to the private houses and shops. Its present capacity is 1,250 lights, which will be augmented, if found to give good results."

Mr. Vice-Consul Pio Consiglio, in a report on the trade of Salerno, says:—"The firm of Andrea Sprecher obtained the concession for electric lighting for the townships of Cava di Tirreni and Vietri last year, and have carried out their work to the satisfaction of all concerned. In connection with their enterprise, this firm has started a flour mill, which is worked by the same power as the electric light, thus making their machinery of use in the day time, when otherwise it would be lying idle."

According to a report received at the Foreign Office from Consul Payton, of Genoa, it appears that electric lighting and electric tram-lines are considerably on the increase, and are mostly, as regards the latter department especially, in the hands of the Allgemeine Elektricitäts Gesellschaft, of Berlin, with a general agency there, while a good deal of lighting is done by the Societa Genovese di Elettricita, and there are many private firms for electric lighting apparatus.

Mr. Vice-Consul Daly, in his annual report on the trade of Bordighera, Italy, says:—"During the year, an English firm of electrical engineers secured concessions for lighting Ventimiglia and Bordighera by electricity, and both these communes now have the electric light. The concession for Bordighera is only applicable to house lighting, as the municipality has an unexpired contract with the Tuscan Gas Company for street lighting. Incandescent lamps of 8 candle-power are charged 20 lire per year, or the light is supplied by meter at the rate of 1·25 lire per Board of Trade unit. The engineers above referred to have also obtained powers for the establishment of a system of electric tramways, and it is hoped the scheme will be carried out before the end of the present year, or early in 1898. These engineers informed me, to my great surprise, that it did not suit them to obtain their plant from England, not because of slight extra expense, English electrical machinery being superior to that of Continental manufacture, but because English manufacturers have no branches in Northern Italy, whereas at Turin and Milan branches are to be found of Belgium, German and Swiss firms, where every information could be obtained, and prompt delivery of goods guaranteed. I should like to express my personal opinion that the greatest impetus which could be afforded by the Government to British trade abroad, would be the legalised adoption of metric weights and measures."

Mr. Vice-Consul Congreve, of San Remo, in his annual report, says:—"The chief work of importance in that district has been the installation of the electric light by a co-operative society, with a capital of 100,000 lire in shares of 100 lire each, the holders being chiefly hotel keepers, and English and other foreign owners of villas; 2,000 lamps have been already set up. The work has been confided to the Alioth Company, of Basle, some of the machinery being supplied by the firm of Tosi, at Leguano. The town itself is still lighted by gas, the municipality being bound by contract with the Tuscan Gas Company."

**Gold Medal.**—Messrs. Edward Humphries, Limited, of Pershore, inform us that they have just received advice from the committee that their improved and patented oil engine has received first prize gold medal of the National and International Agricultural Society of Holland, now being held at The Hague.

**India-Rubber.**—Consul Pickersgill, in his annual report on the trade of St. Paul de Loanda, says:—"There are only two products in the regions of the Upper Congo, as far as its resources are known at present, which are valuable enough to pay the cost of transport, and these are ivory and India-rubber, both of which are, unfortunately, limited in quantity, and slow in growth. It is a mistake, however, to regard the exhaustion of either as inevitable. There is sufficient India-rubber in the forests of the Haut Congo to yield rich harvests for many a year, even at a much greater rate of exportation than the present, which has attained an average of 100 tons per month. Nothing could possibly repay cultivation better. Ivory may be imitated, but caoutchouc remains indispensable, the one tropical commodity of which the consumption is ever on the increase, while the sources of supply are diminishing. The preservation of the climbing plants from which the elastic juice is obtained, and the introduction of trees containing it in greater quantities, is therefore a labour of forethought, to which too much attention cannot possibly be given. Already something has been done in this direction by a few officers of superior intelligence, but others have caused wide stretches of forests to be stripped of wealth with little regard for the needs of the future."

Mr. Carden, in a report on the trade of Mexico, says:—"The large profits to be made by the collection of chicle gum, which requires very little preparation in order to be brought into a marketable condition, have excited a good deal of attention of late, with the result that the exportation in 1896 exceeded by nearly 1,000,000 lbs. that of the preceding year. Hitherto it has been in demand almost exclusively as a chewing gum, but experiments are now being made with a view to ascertaining if it cannot be used for certain purposes as a substitute for India-rubber."

**Notice to Creditors.**—Creditors of Messrs. E. J. E. Tomlyn and W. A. Gent, trading as Eric Tomlyn & Co., ironmongers, and Gent & Tomlyn, electrical engineers, Wellington, Somerset, who executed a deed of assignment in March last, are requested, in a *London Gazette* notice, to send in their names and particulars of debts by October 8th, 1897, to Messrs. Poppleton & Appleby, 164, Aldersgate Street, E.C.

**Technical Education for the 1897-8 Session.**—*The South-West London Polytechnic.*—We have before us the day and evening prospectuses of this Institute for the coming session. They each contain some excellent photographs of the various departments. Mechanical engineering and architecture are taught in Department A by Prof. Pullen and various assistants. Department B is devoted to "Electrical Engineering and Applied Physics," and is under the control of Prof. Herbert Tomlinson, assisted by various gentlemen, including Mr. D. K. Morris, Ph.D., and Rev. A. D. Capel, M.A., who are lecturers in mathematics. The Chemistry Department (C) is in charge of Prof. J. B. Coleman, assisted by three demonstrators. Among the subjects taught at the electrical classes are electrical testing, engine trials, dynamo and motor trials, electric wiring and fitting, instrument making, &c. There are also courses in languages, and the many general subjects, a knowledge of which is necessary for a first class business education, while the wants of those of the fairer sex, who have no desire to dabble in such common-place matters as mathematics or theoretical science, are well catered for in the laundry, cookery, tailor cutting, embroidery, and similar classes. The course of recreation classes is also an admirable one. We understand that the Technical Day College is on the lines of the Finsbury Technical College, and provides a sound and systematic course of training, extending over a period of at least two years, in mechanical engineering, electrical engineering, or applied chemistry. It opened in September, 1896, with only eight pupils; but before its first session was ended, over 70 individual students had availed themselves of the excellent education offered by it. For those who are unable to attend in the daytime, similar classes in the evening are available. Electrical engineering and applied physics seem to be subjects largely sought after in both day and evening classes. During the last session the physics and electrical engineering evening classes were attended by nearly 170 students engaged in one or more of the following subjects:—Applied physics, electrical technology, electric wiring and fitting, and instrument making. None of the technical courses are run on examination lines, the object being simply to give the pupil that instruction which will best fit him for the occupation he has selected; but several of the students have highly distinguished themselves in the examinations of the City and Guilds Institute, whilst others have carried off evening exhibitions offered by the Technical Education Board. As regards equipment, there is little to be desired. Thanks mainly to the London Technical Education Board, something like £10,000 has been spent on the plant requisite for electrical and mechanical engineering, and for the apparatus required in the chemical and physical laboratories. The whole of the Institute is lighted by electricity, which can be generated by its own electric plant, or obtained from the mains of the Chelsea Electric

Supply Company. For the present session, which commences on September 28th, there are already a considerable number of entries in both day and evening engineering classes. We should recommend intending students, who have not yet fixed upon a school, to send stamps to the secretary at the Institute, Manresa Road, Chelsea, S.W., for a copy of these prospectuses.

*The People's Palace*.—The calendar of the East London Technical College, Mile End Road, E., for the 1897-8 session is published, and, as usual, the course of instruction covers almost every subject one can think of. For intending electrical or general engineering students there are classes in mathematics, theoretical mechanics, applied mechanics, special engineering courses, physics, chemistry, telegraphy. In electrical engineering the instructors are Prof. A. G. Cooke, assisted by Messrs. E. H. Shaughnessy, P. H. Grant, and R. S. Friend. Mr. Shaughnessy is also lecturer in telegraphy. There is an electrical society in connection with the classes, which should prove an attraction. Papers are to be read on subjects connected with electrical engineering and telegraphy, and visits will be arranged to electrical works and other places of interest. Messrs. H. Savage and E. H. Shaughnessy are hon. secretaries of this section.

**Telephone Protectors.**—The Western Electric Company, of Coleman Street, E.C., are making a device for protecting telephone subscribers' instruments against lightning and other currents of abnormal strength. The essential parts of the protector are a carbon plate lightning arrester with air space and globule of low melting alloy, two fibre tubes with fuses, and two heating coils. Very strong currents break the circuit by melting the fuse wire, or go to earth across the air space of the arrester; currents of less strength act upon the heating coil.

**The "Bennett-Phythian" Destructor.**—We understand that one of these destructors is being tried for the first time at Farnworth, near Bolton. Mr. F. F. Bennett, of Manchester, who is the designer, has also erected, in connection with the Farnworth destructor, a water tube boiler, 100-H.P. vertical engine, a 50 unit dynamo, and 750 16-C.P. incandescent lamps. From a circular being issued by Messrs. Ham, Baker & Co., of 13, Grosvenor Road, Westminster, who are the manufacturers, we learn that the "Bennett-Phythian" constant high temperature destructor has been designed to effectively destroy house and town refuse, and when desirable, utilise this waste product for raising steam for various useful purposes. A constant temperature of 2,000° can be maintained. It is claimed that in this destructor, falls of temperature during the clinkering and re-charging operations are avoided, the temperature obtained in the central or active cell being practically constant, and rapid deterioration of the cell, consequent upon temperature variation, is largely prevented in consequence of this. The cell is specially designed, we are informed, for electric lighting purposes. In a three-cell destructor described, the central cell is the active one, while the clinkering and charging are performed in the two side cells. When at work the fires are burning upon the grate in two of the cells, the other being empty. The central cell attains a maximum heat, and when it requires re-charging, the grate is moved to bring that part which was in the central cell into the empty side cell, and that which was in the other side cell into the centre; thus, without cooling the central cell or furnace, a fresh charge is brought into it which had been gradually increasing in heat. The grate that has been moved into the empty cell is then clinkered and re-charged, and the blast turned on to it, when it gradually increases in temperature, the products of combustion from it passing over the hotter fire in the centre, until that in its turn requires re-charging, and thus the side cells are alternately re-charged, and the grate moved to carry the charge into the central cell. The grates move on rollers, by means of a rack and pinion arrangement. Forced draught is supplied to each cell. The gases, after leaving the central cell, can directly be utilised for raising steam and maintaining it at a constant pressure by means of a water tube boiler. When desirable, the boiler can be fixed at the side or end of the destructor; but when mounted above the destructor, economy of space and great efficiency are secured.

**The Blot Accumulator.**—A company has just been registered in Paris with the name La Compagnie des Accumulateurs Electriques Blot, the capital being £64,000.

**The National Telephone Company.**—The *City Press* says that the directors have under consideration the plans for the new head officer which it is proposed to build upon the Embankment.

## ELECTRIC LIGHTING NOTES.

**Aberdeen.**—The Town Council has offered to supply current for lighting the quays at a reduction of 12½ per cent. on the Brighton rates. As this would come out about as cheaply as the Harbour Board could do it themselves with a private plant, a Sub-Committee recommends acceptance of the terms.

**Battersea.**—The Vestry will advertise for an electrical engineer to prepare an electric lighting scheme; a selection will be made from three engineers (one of the three to be Mr. R. Hammond).

**Bermondsey.**—By 30 votes to 12, the Vestry has resolved to apply for a provisional order. The committee suggested the compulsory area. Messrs. Kincard, Waller & Manville have prepared a scheme, costing £15,365 to carry out, for supplying 5,250 private lamps, in addition to lighting the public streets.

**Bootle.**—The Watch Committee has reported that the Board of Trade has approved of the proposed system of supply of electric lighting. Plans will now be proceeded with.

**Bolton.**—At a special meeting of the Council, to be held on October 27th, a resolution will be submitted directing application being made to the Board of Trade for a provisional order, authorising the Corporation to supply electricity for public and private purposes in the following townships which adjoin the borough:—Astley Bridge, Tuaton, Horwich, Heaton, Smithills, Darcy Lever, Breightmet, Lostock, Deane, Over Hueton, Tonge, Middle Hueton and Great Lever.

**Boston.**—Last week, the new installation at Boston Dock was officially opened by the Mayoress, in the presence of the Mayor and Corporation. The dock and premises are lighted by eight arcs and 150 incandescents. Messrs. Spagnoletti & Crookes carried out the installation.

**Bradford.**—The Gas and Electricity Committee recommends the City Council to replace all public gas lamps at Heaton and Frizinghall by incandescent electric lamps wherever the electricity mains are available.

**Brighouse.**—The Brighouse Council has appointed a committee to look into the question of electric lighting and dust destruction.

**Bromley.**—The *London Gazette* for September 24th contains notice of the intention of the District Council to transfer their provisional order to the Bromley (Kent) Electric Light and Power Company, Limited. The company, of which we gave a few particulars last week, will pay the Council £361 towards the cost of obtaining the order.

**Carlisle.**—In connection with its £30,000 electricity scheme, the General Purposes Committee recommend the acceptance of the following tenders:—

| | |
|---|---|
| Boilers:—Oldham Boiler Works Company ... ... | £1,600 |
| Engines and dynamos:—Siemens Brothers ... ... | 8,391 |
| Accumulators:—Chloride Electrical Storage Company | 650 |
| Switchboard and motor dynamos:—Electric Construction Company ... ... ... ... ... ... | 1,318 |
| Arc lamps:—Crompton & Co., Limited ... ... ... | 203 |
| Mains:—Callender's Cable and Construction Company | 3,767 |
| Total ... ... | £15,959 |

It is anticipated that the supply will be available before the close of next summer. Plans prepared by the City Surveyor, Mr. Marks, for the station buildings, have been approved, the estimated cost being £4,000 or £5,000.

**Croydon.**—At a meeting of the Town Council on Friday, the Committee recommended—after the reception of a report from Prof. Kennedy—that upon the contractors agreeing to guarantee the sinking fund and interest on the outlay, the necessary mains be laid, and a sub-station erected to cope with the large number of applications received for the extension of the electric light, and that application be made to the Local Government Board for sanction to borrow £5,000 for such purpose. Alderman Miller stated that the applications for the light were three times as many as originally anticipated; but the £5,000 would only be expended on a sufficient guarantee of revenue being given by the consumers. The recommendations were adopted.

**Dartford.**—The Council have decided to apply for a provisional order.

**Denbigh.**—The Town Council has had a letter before it from the Great Western Electric Light and Power Company, asking sanction to its intended application for a provisional order. The Council will take no action at present.

**Dublin.**—The Electric Light Committee has been considering a scheme to improve and extend the electric lighting of the city, and has decided to secure the services of a London electrical engineer, and to advise the Council to borrow £100,000 for the construction of a power station at the Pigeon House Fort.

**Durham.**—The Visiting Committee of the Durham County Asylum, having decided to light the Winterton block of the asylum with electric light, have appointed Mr. Henry G. Templeton—who was formerly assistant to Mr. Jas. A. Jeckell, the borough electrical engineer of South Shields—to advise them on the selection of plant, and to see the work carried out. The tenders of the Corlett Electrical Engineering Company, Limited, of Wigan and Newcastle-on-Tyne—of which Mr. C. W. Fairweather is the local manager—has been accepted for the whole of the plant. The plant will consist of two Crompton's patent continuous shunt-wound dynamos, each having an output of 100 amperes at 230 volts, fitted with shunt resistance for charging the accumulators, and driven by two under-type compound engines by Ruston-Proctor, each of 36 B.H.P. The accumulators are of the I.E.S. type, and will be capable of running 100 16 C.P. lamps for 13 hours. The lighting station is being erected close to the present gasworks at the old asylum, and the current will be carried through bare copper overhead wires to the Winterton Block, a distance of 700 yards. The present installation will consist of 600 16-C.P. lamps, but it is proposed to eventually light the old asylum, when about 1,200 additional lamps will be required, and provision for the extension of the plant is being allowed for.

(*Continued on page* 443.)

## THE DOVER ELECTRICAL TRAMWAYS.

The Corporation electrical tramways were successfully inaugurated at Dover three weeks ago, when some half a dozen cars commenced running. The introduction of electric tramways into Dover may be reckoned an important tribute to the efficacy of the overhead wire system. Hitherto Dover has been wholly free from a tramway service of any description, but for years past the town has been gradually pushing inland, until the outskirts are now at a considerable distance from the centre of the town. Moreover, the construction of the new national harbour, and the prospective development of the Kent coalfields, has had the effect of materially increasing the population, and obviously this has called for an increase in building operations, which have been mainly conducted on the confines of the borough. To provide the residents on the fringe of the town with a quick and easy means of transit, the Corporation resolved to lay down a tramway system, and Mr. Henry E. Stilgoe, the borough engineer, was instructed to prepare plans and sections of the tramways for the session, 1896. A provisional order was obtained from the Board of Trade, and was subsequently confirmed by the Tramways Orders Confirmation Act, 1896.

The Corporation did not by any means decide to use an overhead electrical system without carefully considering the other methods of mechanical traction. Conduits and contact systems were passed in review, and a determined effort was made by the Gas Traction Company, supported by the local gas company, to impress the members of the Town Council with the advantages of gas traction. This system was carefully gone into, and at this stage it will be interesting to quote the Tramways Committee's remarks on comparing gas with electricity.

"With the view, therefore, of comparing the cost of working a gas and an electric tramway, we sent to the Dover Gas Company and the Dover Electricity Supply Company the particulars and questions set out in Schedule 1. These particulars are, of course, not final or binding on you; but with the exceptions hereinafter stated, they are those that we recommend for your favourable consideration. With the view of enabling you to compare the relative cost of these two systems of traction, we framed the questions on the basis that the contracting company would supply everything except men to act as conductors, and the laying and maintenance of the permanent way. There was also the additional reason that, in case you determined to adopt either of the answers received as a basis for negotiation, you might think it right to frame a contract on the principle that the contracting

Some Street Scenes on the Opening Day.

company should be made responsible for efficiency in working, without being able to contend that any fault lay with the Corporation. We append the replies received as shown in Schedule 1 from (1) The British Gas Traction Company, and (2) The Dover Electricity Supply Company. The comparative cost of establishing the two systems in the manner proposed would be as follows:—

Gas.

| | | |
|---|---|---|
| (*a*) | Cars ... ... ... ... | £5,600 |
| | Trailers ... ... ... ... | 660 |
| | Machinery ... ... ... | 1,750 |
| | Total ... ... | £8,010 |
| (*b*) | Cars ... ... ... ... | £5,250 |
| | Trailers ... ... ... ... | 660 |
| | Machinery ... ... ... | 1,750 |
| | Total ... ... | £7,660 |

Electricity.

| | | |
|---|---|---|
| (*a*) | Cars ... ... ... ... | £4,620 |
| | Trailers ... ... ... ... | 660 |
| | Line Equipment ... ... ... | 7,500 |
| | Total ... ... | £12,780 |
| (*b*) | Cars ... ... ... ... | £4,200 |
| | Trailers ... ... ... ... | 660 |
| | Line Equipment ... ... ... | 7,500 |
| | Total ... ... | £12,360 |

"We have not included the cost of permanent way or conductors, which will be the same in both cases.

"The comparative annual cost of the two systems for the (*b*) cars would be as follows:—

Gas.

| | |
|---|---|
| Interest on loan ... ... ... | £230 |
| Instalment ... ... ... | 277 |
| 160,000 miles at 6d. ... ... | 4,000 |
| Total ... ... | £4,507 |

Electricity.

| | |
|---|---|
| Interest on loan ... ... ... | £371 |
| Instalment ... ... ... | 463 |
| 160,000 miles at 5d. ... ... | 3,333 |
| Total ... ... | £4,167 |

showing a saving on electricity of £340 per annum."

The most novel feature in the working of the Dover Electrical Tramways is that the tramway system is owned by the Corporation, and the supply of motive power is furnished by the Dover Electricity Supply Company. We have at various times noted the terms on which current was to be supplied for tramway purposes at Dover, and it will be well to recapitulate them here. The price per unit to be 3d., but the Corporation guarantee the minimum to be 160,000 Board of Trade units. If the consumption of current exceeds 240,000 in the course of 12 months, the price then charged per unit is to be 2¾d. per unit; and should 360,000 units or more be used, the price would be 2½d. per unit. All current used between the hours of midnight and 5.30 a.m. to be charged at the rate of 4d. per unit.

Cars at Terminus.

The tramways, which extend from the Harbour Station to Buckland, are single line with passing places; the total length being 4 miles 3 furlongs 6·05 chains, of which 3 miles 1 furlong 8·15 chains is single line, 1 mile 1 furlong 2·25 chains double line, and 5·65 chains interlacing lines. The centre line of the tramway corresponds with the centre line of the road, except for a short length, where it was necessary to go to one side to pass round a sharp corner. The gauge is 3 feet 6 inches, and was decided by the narrowness of one or two of the streets through which the line passes. At the passing places, which are 3 chains in length, the distance between the centre of each pair of metals is 7 feet 6 inches.

The steepest gradient on the lines is 1 in 13·32; but on the newer portions it does not exceed 1 in 25·69. The sharpest curve is 45 feet radius.

The permanent way, which has been designed by, and carried out under the direction of Mr. Stilgoe, is of a substantial character. The rails are of the girder type, of steel, weighing 87 lbs. per yard. They are 30 feet long, 6½ inches

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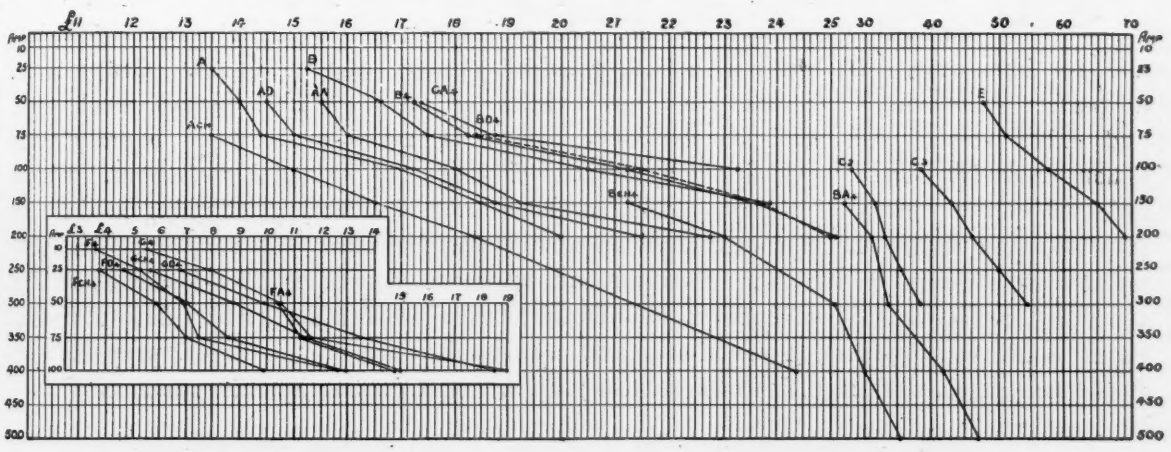

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*Explanation.*—Ninety-two "Standard" Switchboards are priced in the above diagram, and some 200 others will be found listed in Veritys' New E.S. Catalogue. The Company believe they are correct in affirming that never before has the attempt been made to classify, standardise, and stock Main Switchboards. Hitherto the accepted rule in the Electrical Manufacturing Industry has been very much to this effect—that every switchboard manufactured is of necessity different in design from its predecessors, and must therefore be specially made—at the serious inconvenience of the buyer. There appears to be no reason for this, other than the absence of any definite classification. Veritys have for the first time endeavoured to deal with the question, and have expended upon it a considerable amount of time and labour, which they hope the result achieved may justify. By their system all main boards for general purposes are divided into seven types lettered from A to G, and each type is, of course, made in several capacities. But the overall dimensions of a given capacity in one type are in almost all cases identical with those of the same capacity in any of the other types, so that "panel" boards are very readily made up. A panel board might contain, for instance, Type C, which is an Interlocking Dynamo Board; Type E, which is an Extended Type Accumulator Board; and Type F, which is a Main Distribution Board. Added to this it will be seen that a system embodying the adoption of uniform outside dimensions throughout makes the stocking of slates a comparatively easy matter. Thus by keeping a stock of 50 slates Veritys can make up any one of their 300 "Standard" Main Switchboards.

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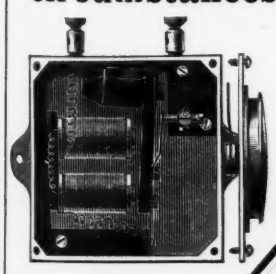

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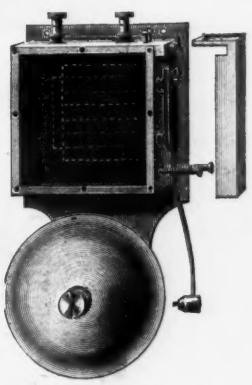

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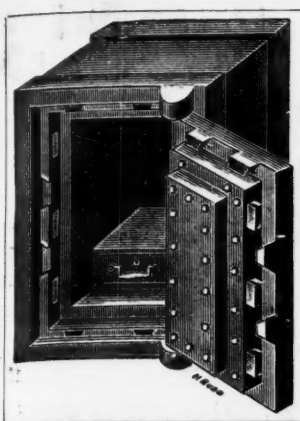

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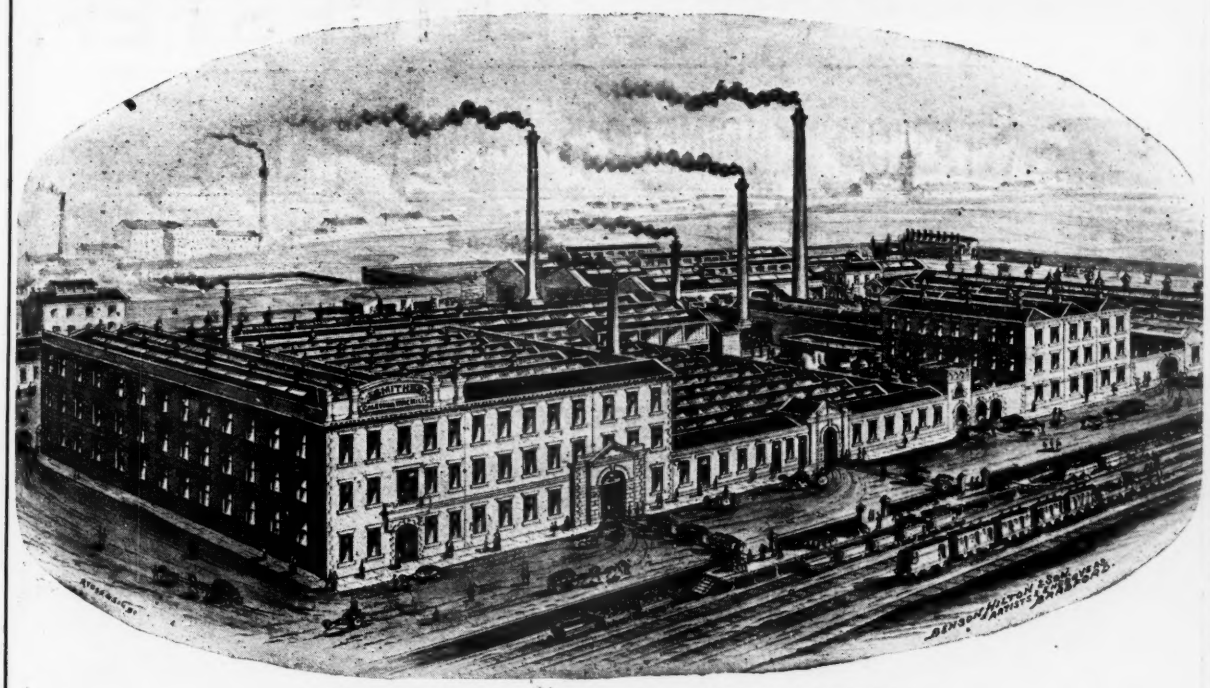

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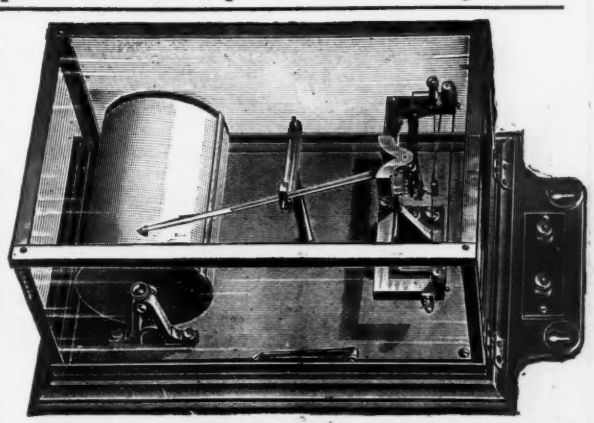
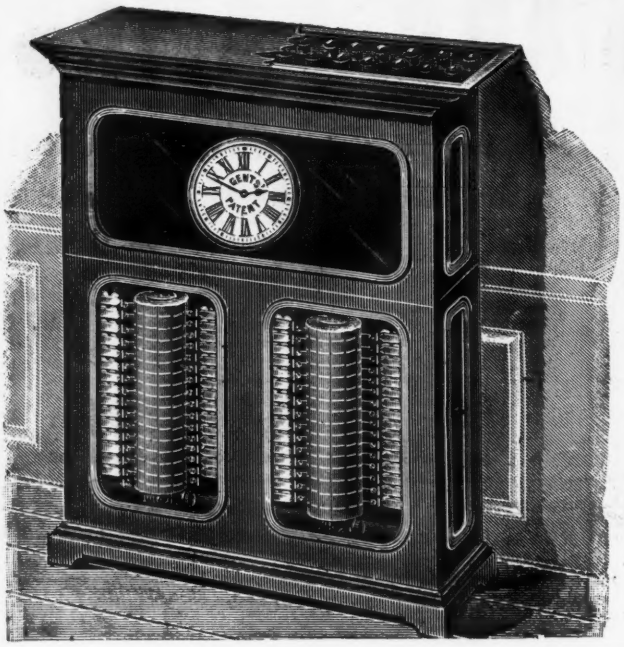
98, YORK STREET, WESTMINSTER, S.W.
(*Next St. James's Park Station*). a962



HOLDEN RECORDING VOLTMETER.
Now made for 200-volt Circuit; Direct or Alternating.
J. PITKIN, 56, Red Lion St., Clerkenwell, E.C.



# GENT & CO.'S

ELECTRIC

## WATCHMAN'S CLOCKS,

Fitted in nearly all the Large Asylums throughout the Country and in many large factories, &c., including

RUDGE-WHITWORTH CYCLE WORKS (Three Clocks),
HUDSON'S SOAP WORKS,
BIRD'S CUSTARD POWDER WORKS,
&c., &c., &c.

*Illustration shows one of a pair of clocks at Lancashire County Asylum.*

ADDRESS:—

FARADAY WORKS,

# LEICESTER.

1145

# STATION ENGINEERS KINDLY PERUSE.

FACSIMILE.

Corporation Electricity Works.

Spa Road, Bolton

August 16th 1897.

TELEPHONE No 269

ARTHUR ELLIS MIEE
BOROUGH ELECTRICAL ENGINEER

MORE

STEAM.

LESS

COST.

Messrs Meldrum Bros.
Atlantic Works
City Road
Manchester

Dear Sirs, In reply to your circular letter of the 12th inst. I beg to inform you that we have your system of forced draught fitted to all our Babcock & Wilcox boilers, 5 in number. We have had them since the works were opened in 1894 & are exceedingly well pleased with the results. We are able to burn "coke breeze" at 1/6 per ton delivered & for all that we run the record may close for coal I find I have used only 1.40 lbs per unit. We are also having four more fitted to our new Babcock boilers.

Yours faithfully
Arthur Ellis

Over

# 5,000

at work.

We are prepared to fix under guarantee, and, if we fail, to remove free of cost.

# MELDRUM BROS.,

Atlantic Works, MANCHESTER, also at

LONDON, PARIS, NEW YORK, &c. 1408

# BROCKIE-PELL ARC LAMP

(LIMITED),

**97, Queen Victoria Street, LONDON, E.C.**

Telegrams: "Illumineers, London." Telephone No. "Bank 294.

## OWNERS OF THE PATENTS AND SOLE MAKERS

of the well-known

BROCKIE-PELL ARC LAMP

as used by

H.M. GOVERNMENT in numerous Departments (over 1,000 lamps).

COLONIAL and FOREIGN GOVERNMENTS. | UPWARDS of 20 RAILWAYS.

OVER 40 CORPORATIONS and VESTRIES. | OVER 50 ELECTRICITY SUPPLY STATIONS

And by Docks, Harbours Mines, Factories, Shops, Theatres, Exhibitions, &c., &c., all over the world.

---

# NOTICE.

On and after 1st June, 1897, all lamps issued by this Company will bear our Trade Mark

# "BROCHIPEL"

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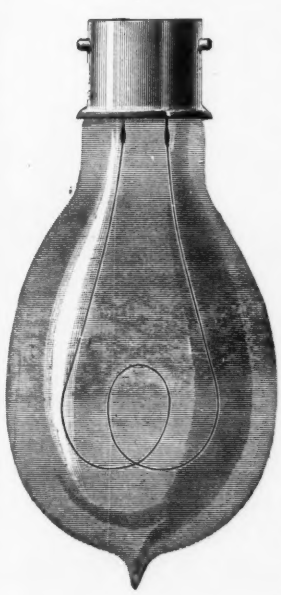


## WHOLESALE DEPÔT

FOR THE

WORLD-RENOWNED

# SIEMENS LAMPS

*Special Terms for Contracts.*

## G. STRAUS & CO., LTD.,

130, QUEEN VICTORIA ST., LONDON, E.C. 1837

---

Telegrams—"EVERYBODY, LONDON." **J. D. F. ANDREWS & CO., LTD.,** Telephone—329, KENSINGTON.

**FULHAM ELECTRIC WORKS, PUTNEY BRIDGE STATION, FULHAM, LONDON.**

J. D. F. Andrews' Patents

Originators, Pioneers, Patentees, and Perfectors of

**SECURITY CONCENTRIC WIRING,**

Extensively introduced into every class of building.

**SECURITY DOUBLE WIRING,**

No wood casing. Same class of work as our Concentric

**LONG LIFE ARC LAMPS,**

The Pioneer of Great Britain.

**Automatic TALK-TO-ALL Telephones.**

J. D. F. Andrews' Patents

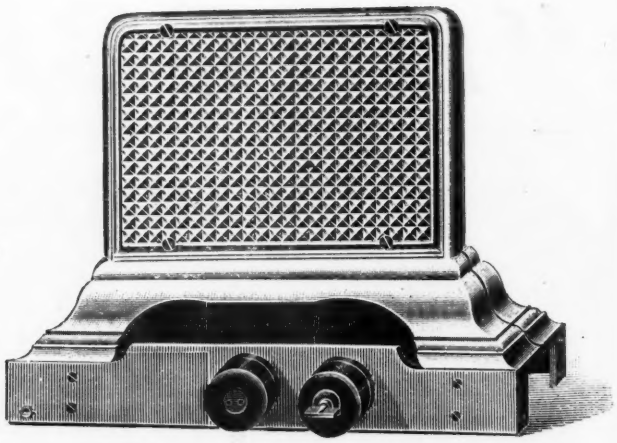
# THE WINTER IS COMING



# PREPARE

## FOR THE COLD WEATHER.

## ELECTRIC RADIATORS OR WARMING STOVES.



These Stoves are especially suitable for

**OFFICES, BEDROOMS, BATHROOMS, &c.**

**No Dirt, Smoke or Smell,**
**Perfect Regulation of Heat,**
**No Danger of Fire, No Noxious Fumes.**

THE

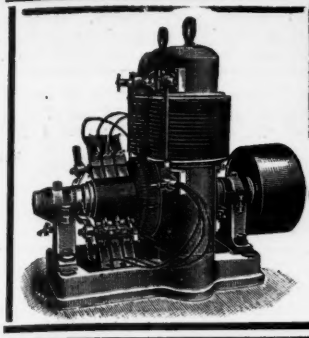
# GENERAL ELECTRIC CO., LD.,

HEAD OFFICES, WAREHOUSES AND SHOWROOMS—
69, 71, & 88, Queen Victoria Street, LONDON, E.C.

**Works**— Peel Works, Adelphi, SALFORD.
Brook Green, HAMMERSMITH.
CLERKENWELL.

**Branches**— 45, Chapel Street, Manchester.
71, Waterloo Street, Glasgow.
39, Corporation Street, Birmingham.
13, Westgate Road, Newcastle-on-Tyne.

11137



# "CASTLE"

## SLOW SPEED. HIGH EFFICIENCY.

## J. H. HOLMES & CO., NEWCASTLE-ON-TYNE, AND 17. SOHO SQUARE W.

# DYNAMOS

1121

TELEPHONE No. 15,077 Telegrams: "INDICES," LONDON.

## WHEATLEY KIRK, PRICE & GOULTY

(ESTABLISHED 1860),

**Electrical Auctioneers, Valuers,**

**AND ARBITRATORS.**

**Average Annual Valuations exceed £1,500,000 Sterling.**

## 49, QUEEN VICTORIA STREET, LONDON E.C.

c3891

**TO ELECTRICIANS, ENGINEERS, AND OTHERS.**

*Preliminary Notice.—Re PATERSON & COOPER, European Works, Pownall Road, Dalston, London, N.E.*

## WHEATLEY KIRK, PRICE & GOULTY

are instructed by the Trustee to

**SELL BY PUBLIC AUCTION,**

at an early date,

**THE ENTIRE CONTENTS**

of the Works Premises.

The Plant includes Cornish Boiler, 21 ft. by 6 ft. diam., Horizontal Steam Engine, 17½ in. cylinder by 36 inch stroke, Vertical High Speed ditto, 10½ by 10½, 27 Slide Surfacing, Screw-Cutting, and Hand Lathes, from 5 in. to 16 in. centres, on straight and gap beds, from 4 ft. to 20 ft., by Muir, and other well known makers; 14 Brass Finishers' Hand Lathes, from 3 in. to 6 in. centres, Radial Drill, 5 ft. arm, 2 Self-contained Vertical Drilling Machines, Quick Speed and treadle ditto, Double Head Shaping Machine, 15 in. stroke, Planing Machine, 7 ft. 6 in. by 3 ft. 6 in., Punch and Shearing Machine, Universal Milling Machine, Screwing Machines, Slotting Machine, 10 in. stroke, Wood Planing Machine, Wood Moulding ditto, Band Saw, Two Circular Sawing and Grooving Machines, Shafting and Gearing. The loose tools and utensils comprise the usual hand tools in fitting, turning, smithy, and foundry. The Stores comprise some dozens 10 amp. arc lamps, incandescent lamps, cable and lighting wire, switchboards, ammeters, voltmeters, reflecting galvanometers, Wheatstone bridges, many gross of cut-outs, switches, telephones, bells, brackets, carbons, china and glassware, bolts and nuts, copper and brass sheet and pipe, lighting and plating dynamos, office furniture and fittings, &c., &c.

Catalogues may be obtained shortly on application to the Trustee, EDWARD C. MOORE, Esq., 3, Crossby Square, E.C., or to the AUCTIONEERS, 49, Queen Victoria Street, London, E.C., and Albert Square, Manchester.

These commodious works, which will be vacated shortly after the sale, offer a good opportunity for those who may be requiring a works in London, suitable for almost any class of trade. 1658

*In the High Court of Justice, Chancery Division.*
*Mr. Justice Romer.*

**THE GENERAL ELECTRIC POWER AND TRACTION CO., LTD. (In Liquidation) v. LEWIS.**

Messrs.

## PERCY HUDDLESTON & CO.

Have received instructions to offer for

**SALE BY AUCTION,**

at the Mart, Tokenhouse Yard at an early date (unless disposed of by Private Contract) the valuable leasehold premises known as the

**COPPER DEPOSITING WORKS,**

WEST FERRY ROAD, MILLWALL, LONDON, E.

having a ground area of about 75,000 feet and having a frontage to the River Thames of 91 feet. The wharf is connected with the various buildings with tramways, and is held at a ground rent of £250 per annum.

The buildings comprise Engine and Boiler Houses, Depositing House, Wire Mill, and other buildings, also Manager's House, Offices, &c. The whole of the fixed plant and machinery will be included in the purchase and include two pair of new Horizontal Compound Condensing Engines, and three High Pressure Boilers, by Davey, Paxman & Co., Dynamos, Vats, Pumping Plant, Cranes, &c.

Further particulars may be had of E. Wilding, Esq., Chartered Accountant, 2, Clement's Inn, W.C.; Messrs. Ward, Perks, & McKay, Solicitors, 85, Gracechurch Street, E.C., and of the Auctioneers, 72, Finsbury Pavement, London, E.C. 1636

# VULCANITE.

HARBURG INDIA-RUBBER C. COMPANY.

London Warehouse: F. WINTER, 138, London Wall, Wood St., E.C.

# EBONITE.

1119

## SITUATIONS VACANT.

**Where Advertisments are to be answered to a given number, letter, or *nom de plume* at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.**

***Original Testimonials should never be sent.***

CITY FIRM of Electrical Engineers have vacancy for Pupil, premium £50, good opening.—1,669, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1669

COMMERCIAL Traveller wanted, with good connection with electrical contractors, for the sale of electrical supplies.—1,676, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1676

ENGINEER.—A thoroughly practical Man required on a country estate, competent to take charge of a plant consisting of a 10 H.P. steam and 4 H.P. oil engine, with dynamo and accumulators, and superintend installation of about 300 lights. Highest references as to ability and personal character required; wages £70.—Address, "N. N.," care of Willing's, 162, Piccadilly, W. 1668

ENGINEER Wanted, a thoroughly practical man, competent to take charge of electric light plant, high speed engines, laundry and kitchen machinery, heating, ventilating, pumping, and soft water apparatus. Salary £2 2s. per week, with house, coals, and vegetables.—Applications to be sent to the MEDICAL SUPERINTENDENT, West Sussex County Asylum, Chichester. 1660

ELECTRICAL DRAUGHTSMAN, well used to switchboard work.—State salary and references.—VERITYS, LIMITED, Victoria Works, Aston. 1687

GOOD BRASS FINISHER Wanted in electrical works in Yorkshire, accustomed to brush holder and switch work.—State age, experience, and wages required, 1,674, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1674

MANUFACTURING Electrician requires Young Man to take entire charge of small workshop; must have had similar experience, and be able to turn out work at competitive price.—State full particulars to 1,629, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1629

TWO First-class Art Metal Workers, well up in the manufacture of electroliers, wanted for Sheffield. Good wages to first-class men.—Apply, with testimonials as to past work, to 1,675, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1675

THE MANAGER of the Electric Light Company at one of the most healthy towns on the South Coast, has a vacancy for a Pupil. Address 1,647, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1647

WANTED, First-class Wiremen used to country house work.—Apply, F. A. GLOVER & Co., 97, Queen Victoria Street, E.C., with testimonials. 1678

WANTED, a Gentleman to act as Town Traveller, for the sale of incandescent electric lamps of admitted superiority, which command an extensive sale. Good salary and commission to suitable persons. Only applications from men of first-class experience, connection and ability will be considered.—Apply by letter before October 6th, 1,656, ELECTRICAL REVIEW, 4 Ludgate Hill, London. 1656

WANTED, Armature Winders.—Apply, EDISON & SWAN UNITED ELECTRIC LIGHT CO., LTD., Broadheath, near Manchester. 1685

## SITUATIONS WANTED.

A.I.E.E., at present engineer and contract manager with London firm, with 10 years' mechanical and electrical experience, land and ship installations, control of men, estimating and business experience, good draughtsman, wishes engagement in similar capacity in London.—1,651, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1651

[*Continued on next page.*]

A.I.E.E., six years' mechanical and electrical experience, draughtsman, speaks French, desires engagement.—"C. P.," 17, Nevern Square, S.W. 1684

ARC LAMP ERECTOR or Repairer (young) seeks Situation. —"G. B.," 24, Lewin Road, Streatham. 1677

AS Manager of Installation Business, six years' practical and business experience, age 24. Excellent references; moderate salary.—Address, 1,680, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1680

AS Engine Driver, Stoker, or in charge of hydraulic machinery; many years' experience.—References permitted to Editors REVIEW —1,396, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1396

AS CLERK or STOREKEEPER, six years' experience with manufacturers, knowledge of installation work, good references.—1,604, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1604

A.I.E.E., 8 years' experience dynamo design and construction, estimating, installation work, business experience, seeks re-engagement.—1,642, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1642

CHEMIST, with elementary electrical experience, constructive in details.—1,667, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1667

ELECTRICAL ENGINEER (25) seeks engagement as Assistant in electrical engineer's office or as assistant manager. Five years' practical experience installation work, electric plants, central station work, estimating; highest testimonials —1,666, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1666

ELECTRICAL ENGINEER desires appointment, 14 years' experience, good testimonials.—"McM.," 14, Cedar Grove, Old Charlton, Kent. 1665

ELECTRICIAN, Experienced in management of men, estimating, carrying installations, and manufacturing plant and fittings, requires re-engagement.—"G. M.," 5, Almeida Street, N. 1682

ENGINEER requires Situation at Electric Supply Company to take charge of engines, boilers, and their repairs; nine years' experience with high speed electric engines; good references.—"H. G. G.," 29, Victoria Road, Harborne, Birmingham. 1679

ELECTRICAL ENGINEER (24) seeks position, home or abroad. Well up in all descriptions of installation work; speaks French fluently; good references.—1,643, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1643

ELECTRICAL ENGINEER (24) desires Engagement. Two years' experience in large shipping company as sea-going electrician-in-charge.—Address, 1,586, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1586

ELECTRICAL ENGINEER (32), eight years' workshop and drawing office experience, over four years' estimating, designing and installation work, desires Position, home or abroad. Speaks German; good references.—"E. C. R.," 31, Oxford Road, Putney, S.W. 1598

ELECTRICIAN, 10 years' shop, drawing office, and installation experience; also charge of plant. Good references.—1,590, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1590

HOME OR ABROAD.—Electrical Engineer seeks re-engagement; good and varied experience in installation work, manufacturing, estimating, and control of men.—"B. W.," Willing's, 162, Piccadilly, London. 1611

HOUSE WIREMAN-CARPENTER, Surface, Practical, wants work.—5, Farrant Street, Queen's Park. 1664

LIGHTING, Wiring, Plant, Telephones, Bells. Employment by experienced man, accustomed to good class work.—"J. M.," 23, College Street, Islington. 1683

LABORATORY ASSISTANT (34), Electrical Mechanician. Good Draughtsman, skilled in installation management.—1,594, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1594

TRAVELLER (provincial) wants appointment, 10 years' experience in the trade generally, with good connection.—Address, "Traveller," at Horncastle's, 61, Cheapside, E.C. 1687

WANTED, situation as Improver or Assistant in central station, London preferred, by electrical engineer of seven years' practical experience.—1,673, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1673

## ARTICLES FOR SALE AND WANTED, PARTNERSHIPS, &c.

ACCUMULATORS (old), Copper Cable, Scrap Metal, Metal Dust, and Metal Refuse of any kind bought for cash.—Write A. BROWN, 77, Lansdown Road, Dalston, London. 1368

ACCUMULATOR Charging.—C. H. Cathcart & Co., having plant specially adapted for this purpose, charge cells of all sizes promptly, thoroughly, and cheaply. Terms on application. Accumulators on hire for temporary lighting, experimental uses, &c.—3, Dorset Buildings, Salisbury Square, Fleet Street, E.C. (Telephone No. 65,266). 7345

ELECTRIC ENGINEERING and Lighting Business for disposal (established) in a city having Electric Supply Station, and over 300,000 inhabitants, manufacturing district. Considerable development in the use of electric light and power now going on; satisfactory reasons for disposal.—Principals only need apply to Messrs. SNOWBALL & Co, Mechanical Valuers, Fire Loss Assessors, Side, Newcastle-on-Tyne. 1668

INVESTMENT —An old established and large electrical supply house contemplate opening branches shortly in Birmingham, Manchester, Newcastle, and Glasgow, is desirous of negotiating with gentlemen thoroughly acquainted with the electrical trade to take charge of such branches with a view to partnership.—Capital required. Letters, with fullest particulars, to 1,579, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1579

LESSONS BY CORRESPONDENCE in Electric Light and Power Engineering, based on City and Guild's requirements. Preliminary Course, 12 lessons, 6s. 6d. Ordinary Grade, "Course A," 15 lessons 10s. Honours Grade (Central Station Working and Transmission of Power Installations), Course B, 20 lessons 25s. For syllabus and full particulars, apply, "ENGINEER," 83, St. Dunstan's Road, Hammersmith, London, W. 1583

PLATINUM in any form and quantity, purchased at highest prices by DERBY & Co., 44, Clerkenwell Road, London. 6323

WANTED, Electric Lamp Tops and Scrap Platinum.—EDEY AND CO, 29, Ludgate Hill, London. 1478

WANTED, for One Week's Experimental Work, the use of a 4 to 10 H.P. boiler in place.—State full particulars, including rent and stoker's salary, 1,654, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1654

WANTED.—Gas Engine, Dynamo, Accumulators, second-hand; must be in first rate working order. Battery at least 300 amp.-hours' capacity at 9 hours' discharge; engine and dynamo to suit. State manufacturer's name, how long in use, and all particulars.—Address, 1,681, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1681

WANTED the loan of a small model electric tramway (overhead system preferred) for a public lecture.—Apply 1,686, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1686

**L. GARDNER & SONS,** DYNAMOS, MOTORS
**MANCHESTER.** GAS ENGINES.
See Page Advertisement Third Friday of each month.

**ENGELBERT & Co., London,**
LUBRICANT MANUFACTURERS,
*Vide* full advertisement in last issue, also next issue.

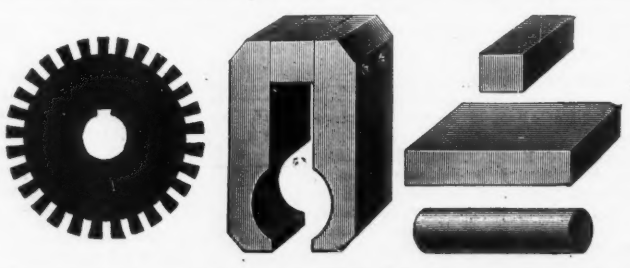
# TO MANUFACTURERS OF DYNAMOS, MOTORS, TRANSFORMERS, &c.

**STAMPINGS OF ALL DESCRIPTIONS,**

**DISCS up to 60 inches diam.**

**SLOTTED WORK a specialty.**

**Accuracy of Stamping and Highest Electrical Results Guaranteed.**



**MAGNETS—Forged, Rolled, Cast or Stamped, Finished, or in the Rough.**

**SLABS & BARS in Suitable Sections for Magnets, Cold Sawn to lengths.**

ROLLED AND FORGED SHAFTING, EYE BOLTS MICA, COMMUTATOR SEGMENTS, &c. 1345

**ROBERT JENKINS,** 88, BISHOPSGATE ST. WITHIN, LONDON, E.C.
Telegraphic Address:—"Permeable, London."

WE ARE NOW SUPPLYING A

SMALL

# GAS ENGINE & DYNAMO COMPLETE,

Capable of Lighting CONTINUOUSLY

## THREE 8-VOLT LAMPS,

OR CHARGING

## FOUR 6-VOLT ACCUMULATORS,

AT

## £10 10s., subject.

SEND FOR LIST.

# H. M. SALMONY & CO.,

MANUFACTURING ELECTRICIANS,

118-120, Charing Cross Road, London, W.C.

Telephone, 5,479, GERRARD. Telegrams:—"SALMONY, LONDON."

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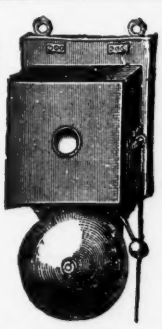
ELECTRIC Bells, Pushes, Lamps, Wires,



Telephones, Batteries, Switches, Electro-Medical Apparatus.

*Price List of Electrical Accessories on application.*

LIBERAL DISCOUNTS TO THE TRADE.

**S. HARRISON, Manufacturing Electrician,**

Office—697, ORMSKIRK ROAD, PEMBERTON, WIGAN.

Works—ELLESMERE MILL, NEWTOWN, WIGAN.

Registered Telegraphic Address:—"HARRISON, PEMBERTON."

1107


## Educational Notices.


### CITY AND GUILDS TECHNICAL COLLEGE, FINSBURY.

**LEONARD STREET, E.C.**

SESSION 1897-98.

EVENING CLASSES.

THE NEW SESSION begins on Monday, October 4th, at 6 p.m. Lectures and Laboratory Work, Mechanical and Electrical Engineering, Industrial and Technical Chemistry, Applied Art, including Lectures on Domestic Furniture and Practical Instruction in Enamels and Art Metal Work; Drawing, Painting, &c.; Special Trade Classes in Cabinet Making, Carpentry and Joinery, Metal Plate Work and Plumbing.

The programme may be obtained at the College, Leonard Street, Finsbury, or at the Head Office of the City and Guilds of London Institute, Gresham College, E.C.

JOHN WATNEY,
*Honorary Secretary of the Institute.*

1671

## Educational Notices.

### CITY & GUILDS OF LONDON INSTITUTE

**Central Technical College, Exhibition Road, S.W.**

SESSION 1897-98.

**ELECTRO-CHEMISTRY.**

A SPECIAL COURSE OF INSTRUCTION in Electro-chemistry will be given at the City and Guilds Central Technical College during the Session.

The Course will include practical instruction in Electro-Deposition, the use of the Electric Furnace, Dynamos, Transformers and Accumulators. A great part of the time of the students attending this course will be devoted to Electro-Chemical Research and the study of Electro-Chemical action.

Candidates for admission will be required to submit evidence of having a general knowledge of Physics and Chemistry, and of having been specially trained in one of these subjects.

For further particulars, application should be made to the DEAN OF THE COLLEGE, PROFESSOR W. E. AYRTON, F.R.S.

The Programme of the College may be obtained at the College, Exhibition Road, S.W., or at the Head office of the Institute, Gresham College, Basinghall Street, E.C.

JOHN WATNEY,
*Honorary Secretary.*

1659


## Official Notices.

### BOROUGH OF MORLEY.

**ELECTRICITY DEPARTMENT.**

THE Corporation of the Borough of Morley are prepared to receive applications for the post of Jointer at £104 per annum. Applicant will be required to trim and help regulate arc lamps, to do all work in connection with house services, and must have had experience with Callender concentric cables.

Applications endorsed "Jointer," stating age, previous experience, when duties can be commenced, and enclosing copies of two recent testimonials to be sent to the undersigned not later than October 11th, 1897.

H. W. CLAYDEN,
*Borough Electrical Engineer.*

Electricity Works, Morley,
*September 28th*, 1897.

1661

## Official Notices.

# ELECTRIC LIGHTING ACTS AND ORDERS.

THE LONDON COUNTY COUNCIL gives notice that it proposes, subject to the approval of the Board of Trade, to prescribe the following scale of fees for testing electricity meters, &c.:—

SINGLE OR DISPUTED METERS

(used or to be used in any district for which the Council is the statutory authority).

For testing a single meter *of any description* up to 50 amperes capacity ... ... 10s.
" " of capacity of 50 to 100 amperes 20s.
" " " 100 to 200 " 25s.
" " " 200 to 400 " 30s.

For testing each "disputed" meter the charge shall be as above, and no reduction shall be made if a number of disputed meters be sent in together.

BATCHES OF METERS.

For testing meters, delivered at and removed from the testing station free of cost to the Council, any work necessary for adjusting inaccurate or defective meters being charged for extra—

CLASS 1.—Meters without shunt coils and not requiring to be fixed for testing, up to 50 amperes capacity, if sent in in batches of not fewer than 10 of the same size and make, each ... 6s. 6d.
Do. do. do. from 50 to 100 amperes capacity each... ... 9s.
Do. do. do. from 100 to 200 amperes capacity, each ... 12s.

CLASS 2.—Meters with shunt coils or requiring to be fixed for testing, up to 50 amperes capacity, if sent in in batches of not less than 10 of the same size and make, each ... ... 7s.
Do. do. do. from 50 to 100 amperes capacity, each ... 10s.
Do. do. do. from 100 to 200 amperes capacity, each ... 13s.

CLASS 3.—Meters requiring fixing and synchronising, up to 50 amperes capacity, if sent in in batches of not less than 10 of the same size and make, each ... ... ... ... 8s.
Do. do. do. from 50 to 100 amperes capacity, each ... 12s.
Do. do. do. from 100 to 200 amperes capacity, each ... 17s. 6d.

CLASS 4.—Meters for multiple circuits will be charged for according to the number of circuits.

CLASS 5.—Meters which require to be tested on a circuit absorbing considerable power will be charged for at special rates.

*A reduction of 10 per cent. from these prices to be allowed when 20, and of 25 per cent. when 50, meters of the same make and capacity are sent in at the same time.*

Partial re-tests made on any meter after adjustment will be charged, according to amount of work involved, at one-fourth to one-half of the fee charged for single or disputed meters.

INSPECTION IN SITU.

For examining in position after fixing, and certifying if found correct, any single meter (which has already been tested for accuracy at the Council's testing station) within a radius of three miles from Cranbourne Street ... ... ... ... ... ... 2s. 6d.
Do. do. do. any distance from three to six miles ... ... ... 3s. 6d.

For examining in position after fixing, where a number of meters in the same district, and within a reasonable distance of each other can be inspected on the same day, £1 for the services of the inspector for the entire day, or 15s. for half a day. A further charge of 6d. will be made for each certificate.

ELECTRIC PRESSURE.

For taking a record of "pressure" at any consumer's house within three miles of the testing station, such record extending over 24 hours ... ... 10s. 6d.
If such record extends over two or more consecutive periods of 24 hours, for each such succeeding period 5s.

SERVICE LINES.

For testing a single pair of service lines ... ... 10s.
In difficult cases (in addition to the fee of 10s.) for every hour or part of an hour occupied after the first two hours ... ... ... ... ... ... 3s. 6d.
For testing any installation for insulation resistance to earth, for every 50 lamps (of not exceeding 16 candle-power) installed ... ... ... ... 10s.

NOTE.—*The above fees are to include omnibus fare for the inspector, but all other travelling expenses to be charged in addition.*

Anybody or person desiring to object to the proposed fees may do so by letter addressed to the Board of Trade within one month from October 1st, 1897.

C. J. STEWART,
*Clerk of the Council.*

County Hall, Spring Gardens,
*September 30th*, 1897.

1649

## Official Notices.

# CITY OF WAKEFIELD.

THE CORPORATION OF THE CITY OF WAKEFIELD are prepared to receive Tenders for the Electric Light Wiring of the Town Hall. Plans can be inspected, and copies of the specification and conditions of contract can be obtained at the Town Clerk's Office on payment of a deposit of 10s., which will be returned on receipt of a *bonâ fide* tender.

Tenders are required to be sent under cover addressed to the Town Clerk, Wakefield, and marked "Tender for Electric Wiring," on or before SATURDAY OCTOBER 2nd, 1897.

The Corporation do not bind themselves to accept the lowest or any tender.

CHAS. JAS. HUDSON,
*Town Clerk.*

Town Hall, Wakefield,
*September 18th*, 1897.

1616

# COUNTY BOROUGH OF BURNLEY.

THE ELECTRIC LIGHTING COMMITTEE are prepared to receive applications for the appointment of Assistant Electrical Engineer and Manager, who must be capable of taking charge of the electric lighting station, and of acting as General Assistant.

Applicants should be good draughtsmen and be competent to test mains, meters, &c. Salary £2 per week.

Applications endorsed, "Assistant Engineer," stating age and previous experience, together with copies of not more than three recent testimonials to be forwarded to the Electrical Engineer, Mr. W. R. WRIGHT, at the Electric Lighting Station, Burnley, not later than 10 a.m. on TUESDAY, OCTOBER 5th, 1897.

WM. T. FULLALOVE,
*Town Clerk.*

Town Hall, Burnley,
*September 20th*, 1897.

1640

# CEYLON.

INSTRUCTOR IN ELECTRICAL ENGINEERING AND TELEGRAPHY FOR THE TECHNICAL COLLEGE.

A GENTLEMAN is required to take charge, under the Superintendent of the College, of the Department of Electrical Engineering and Telegraphy (including Telephony). He will be required to teach classes in these subjects, and he will have an Assistant. The principal work of his department will be training telegraph and telephone operators for the Government Postal and Railway Departments. Engagement, in the first instance, for three years. Salary Rs. 4,200 per annum (the present rate of exchange is about 1s. 3d.)

QUALIFICATIONS.

1. Candidates must have passed creditably a two years' course at a technical college in mechanical and electrical engineering and chemistry.
2. Must have served two years in the workshops and one year in the drawing office of a good electrical engineering firm.
3. Must have a practical knowledge of telegraphy and telephony.
4. Must have been teaching for not less than one year some of the subjects comprised in a college course of mechanical or electrical or telegraphic engineering.
5. Age must be from 25 to 30 years.

Free first-class passages for himself and family (if any), not exceeding five in all, out and home again, on satisfactory termination of engagement.

Applications, stating age and experience, and accompanied by copies of testimonials (not originals) with the names and addresses of references of whom enquiry may be made, will be received by the Crown Agents for the Colonies, Downing Street, London, S.W., up to OCTOBER 13th, 1897.

The Crown Agents possess no further particulars respecting this appointment, and cannot, therefore, undertake to answer enquiries.

1635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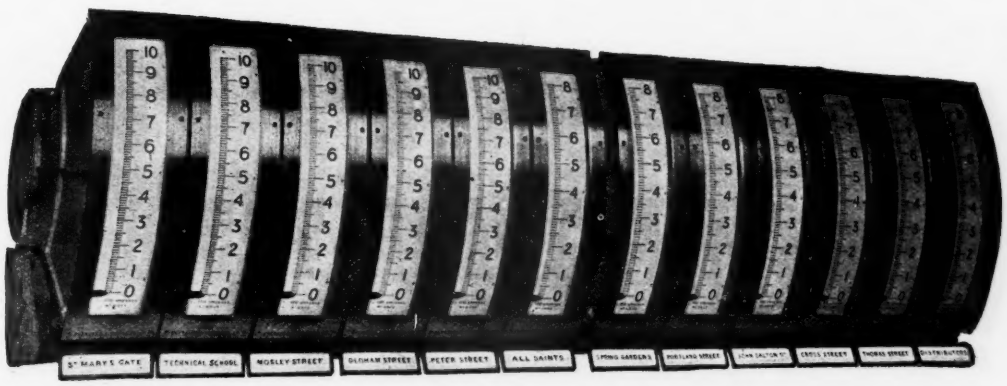


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1477

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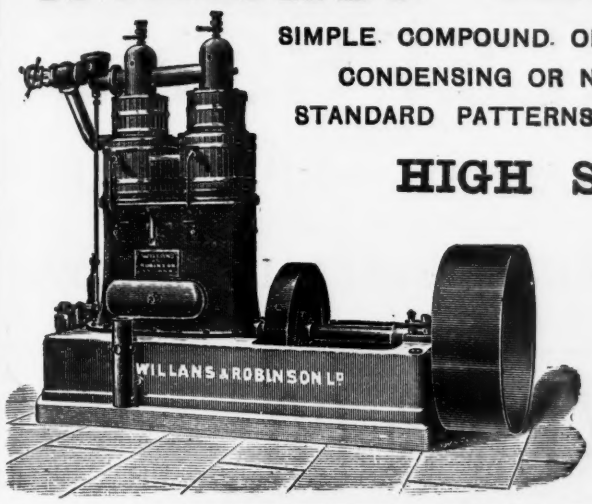


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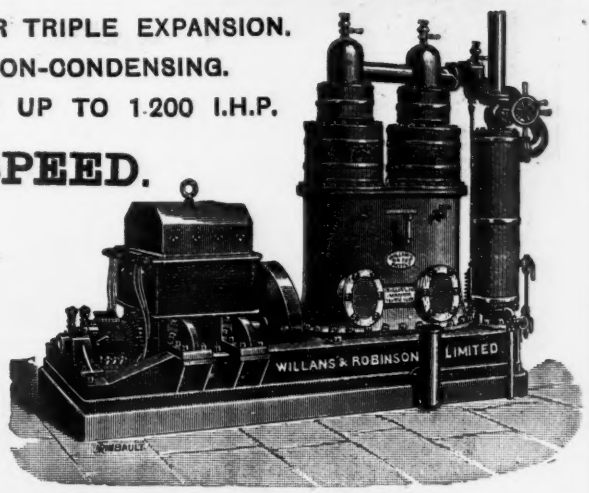


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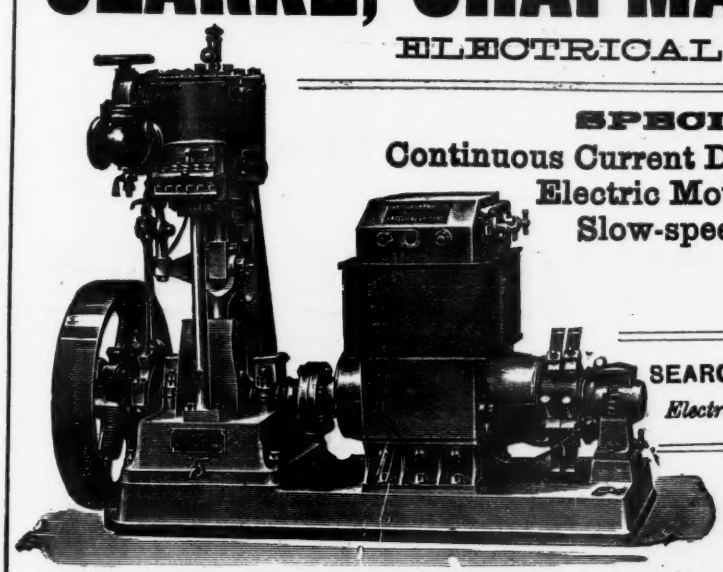

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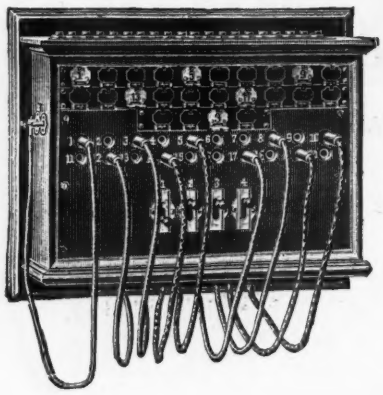

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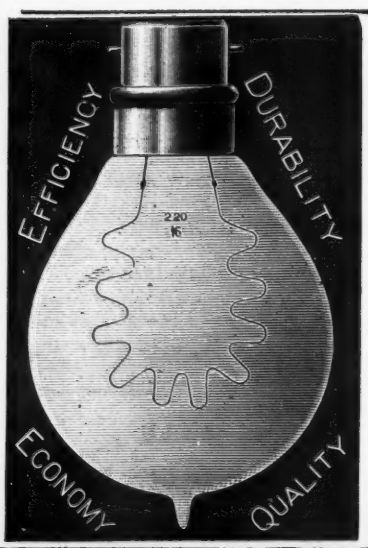


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# ACCESSORIES

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deep, and are slotted for the tie bars and drilled for the fish bolts and electrical bonding. A portion of the head of the rail is cut away at the joint for fitting the outer fish plate.

The fish plates are of steel, 20 inches long, and are of special design, the patent of Messrs. Dick, Kerr & Co.

The outer plate is of the full height of the rail above the flange, and fits into the portion of the head of the rail cut away to receive it. The object of this high fish plate is to add strength to the rail at the joint, which is its weakest part, as may be seen by examining rails which have been laid for a considerable time. The fish bolts are of wrought-iron, $\frac{7}{8}$ inch diameter, there being four bolts to each joint.

The tie bars are also of wrought-iron, 2 inches × $\frac{3}{8}$ inch, with a double-grooved head to fit the slot in the rails; they are placed 8 feet centre to centre, and 3 feet from the ends of the rails.

The points and crossings are of crucible cast-steel, except two or three special crossings, which are built from the girder rails. Marshall's patent spring points are used, and are 7 feet 6 inches long.

The crossings are usually 4 feet long, and the angle is 1 in 5.

Dawson's patent drain rails are used at various points, their use being to drain the water from the groove in the head of the rail into the drains in the street.

The passing places, which, as before mentioned, are 3 chains in length, are laid in the centre of the roads; the distance between the centre line of each pair of metals is 7 feet 6 inches where they run parallel. These are designed so that two or even three cars may stand on one pair of metals, while the same number of cars pass on the other.

The reverse curves from the single to the double lines are 300 feet radius, and allow the car to travel with great ease, with the consequent comfort of the passengers and saving of wear and tear to the rolling stock.

Each rail is laid on a continuous block of Portland cement concrete (5 to 1) 12 inches wide and 8 inches deep. The concrete is mixed and laid with great care, and finished to a true surface; the roadway between the rails, and for a distance of 25 inches outside of each rail, is paved with Guernsey granite setts, 5 inches deep and 4 inches wide, $\frac{5}{16}$ths inch above the level of the rails, grouted in with Portland cement mortar (3 to 1) well swept into the joints, and laid on a ½-inch bed of sand on a 6-inch foundation of Portland cement concrete (7 to 1).

The power station of the Dover Electricity Supply Company is situated about the centre of the system. The generating plant, which is exclusively employed for running the tramway service, consists of two 200-horse-power Babcock and Wilcox water-tube boilers, and two horizontal tandem compound engines, running at a speed of 235 revolutions per minute, and coupled direct to four-pole compound-wound railway generators, giving an output of 100 kilowatts at 500 volts.

According to the terms of the contract, the steam consumption of each engine is not to exceed 18½ lbs. of steam at 150 lbs. pressure per indicated horse-power per hour, and the over-all efficiency of each engine and generator combined, that is to say, the ratio of the energy available at the terminals of the machines to the indicated horse-power of the engine driving it is not to be less than 84 per cent. The engines are by McIntosh & Seymour, the generators being of the General Electric Company's type.

A motor generator of a capacity of 30 kilowatts is provided, the motor side receiving current at 2,500 volts, at a frequency of 100, and the dynamo side generating current at 500 volts and 60 amperes. This arrangement is used when the main engines are shut down.

Separate switchboard panels of enamelled slate are provided for each dynamo and the motor generator, together with ammeters and voltmeters, both continuous recording and otherwise, automatic circuit breakers with magnetic blow-outs, lightning arresters, and recording wattmeters for measuring the consumption of energy, and the apparatus required for complying with the requirements of the Board of Trade.

Recording instruments have been fitted at the offices of Mr Stilgoe, who can thus check the station instruments.

The Service in Operation.

The line is provided with two No. 0 B. and S. special copper wires extending the whole length of the route, carried 21 feet 6 inches from the ground on ornamental tubular steel poles.

The steel poles are 31 feet long; the first section is of 6-inch pipe 16 feet 6 inches long, the second section of 5-inch pipe 7 feet 3 inches long, and the third section of 4-inch pipe 7 feet 3 inches long. The base has an ornamental cast-iron sleeve, and the top is fitted with a cast-iron terminal or lamp, as required. They are sunk 6 feet in the ground, and set in concrete, and are placed 40 yards apart where the line is straight.

Side brackets are fixed to the poles when placed on the kerb, the lengths of the arms being adapted to the varying widths of the roads, and double brackets when the poles can be placed between the double lines; for instance, along the Market Square.

Steel guard wires with insulated supports are fixed where necessary for the protection of telegraph and telephone wires.

The tramways is divided into three sections, radiating from a central feeder pillar, and is further divided into ½-mile sections at suitable switch pillars. On some of the posts ornamental arc lamps are to be provided.

The cars, which have been made by the Brush Company, are capable of holding 20 passengers inside and 24 out, and are carried on Peckham spring cantilever trucks and provided with two G.E. 25 horse-power motors, the series parallel controllers of the usual type, and mechanical brakes, &c. A special feature is the fitting of a wattmeter on each car, so that the consumption of energy on each car can be recorded.

At the present time there are eight motor and two trailer cars.

The trolley is of the special type patented by Mr. Phillip Dawson, and supplied by Mr. R. W. Blackwell, who has supplied the line material and the Chicago bonds. The generating plant, motors and controller, has been supplied by the Thomson-Houston Company. The principal contractors have been Messrs. Dick, Kerr & Co., who have been represented at Dover by Mr. Lawson. The consulting engineer for the whole of the work has been Mr. Stephen Sellon.

A car shed is being built at Buckland, and another will be built at Maxton, from designs prepared by Mr. Stilgoe.

It is intended to run a 10-minutes' service on some of the tramway sections, and a 15-minutes' service on others.

We are indebted to Mr. Stilgoe for conducting us over the line on the occasion of our visit, and in compiling the foregoing details we have made liberal use of the paper which he communicated to the Incorporated Association of Municipal and County Engineers last April. For the series of illustrations showing the street scenes on the opening day our thanks are due to Mr. W. Parsons, the Editor and proprietor of the *Dover Observer*, who generously placed a set of photographs at our disposal.

## THE ADVANTAGES OF SYNCHRONOUS MOTORS IN ALTERNATING CURRENT STATIONS.

The use of over excited synchronous motors where possible has frequently been advocated for central alternating current stations which supply power to inductive circuits. The condenser action of a highly excited synchronous motor is well known, so that by a judicious placing of such motors the main current may be kept in the neighbourhood of its minimum value for a given amount of power transmitted. By doing this not only are the copper losses minimised, but the regulation of the generating plant is rendered much easier than if subjected to the baneful influences of an idle lagging current.

The effect of a rotary converter, is, like a synchronous motor, to cause a leading current if highly excited.

The *Elektrotechnische Zeitschrift*, of May 13th, 1897, contains some observations by R. Klasson on the influence of rotary converters on the power factor of the three-phase central station of the royal powder factories of Ochta, near St. Petersburg. This plant has a low power-factor during the day time when nothing but motors are connected to the mains, and some of them very lightly loaded. Connected to the mains are two three-phase rotary converters which are used at night for arc lamps and for charging accumulators. There are two generators of the Schuckert type, one giving 33·8 amperes at 2,050 volts and 428 revolutions per minute, and the other 50 amperes at 2,050 volts and 300 revolutions per minute.

The following tables give the results of Mr. Klasson's observations:—

Table I.—Maximum Out-put of the Generator, 120 Kilowatts; Maximum Out-put of the Rotary Transformer, 24 Kilowatts.

| Experiment. | External high pressure circuit. | | | | | Exciting circuit. | | | | Revolutions per minute of three-phase dynamo. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Volts. | Amps. | Kilowatts read from the kilowatt meter. | Kilowatts calculated from volt-amperes. | Power factor. Per cent. | Volts. | Amps. | Watts. | Per-centage of output. | | |
| *a* | 2,050 | 27·5 | 60 | 97·7 | 61·2 | 63·5 | 19·5 | 1,335 | 2·22 | 434 | Rotary transformer excited with 2·5 amps. (normal excitation). |
| *b* | 2,025 | 22·0 | 60 | 77·2 | 77·5 | 63·3 | 18·0 | 1,140 | 1·90 | 410 | Rotary transformer over-excited with 4·5 amps. (measuring instruments steady). |
| *c* | 2,010 | 33·5 | 60 | 117·0 | 51·2 | 70·0 | 20·0 | 1,400 | 2·35 | 441 | Rotary transformer under-excited with 1·5 amps. |

Table II.—Maximum Out-put of the Generator, 120 Kilowatts; Maximum Out-put of the Rotary Transformer, 24 Kilowatts.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *a* | 2,000 | 31·75 | 45 | 110·0 | 41·0 | 69·0 | 19·0 | 1,310 | 2·92 | 441 | |
| *b* | 2,025 | 17·0 | 48 | 60·0 | 81·0 | 61·0 | 17·0 | 1,035 | 2·16 | 415 | Rotary transformer over-excited with 4·5 amps. (instruments all steady). |

Table III.—Maximum Out-put of the Generator, 175 Kilowatts; Maximum Out-put of the Rotary Transformer, 24 Kilowatts.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *a* | 2,005 | 32·5 | 80·8 | 112·2 | 72·0 | 55·5 | 29·75 | 1,645 | 2·04 | 300 | Rotary transformer excited with 2·5 amps. (normal excitation). |
| *b* | 2,090 | 24·2 | 83 | 87·5 | 95·0 | 53·88 | 29·2 | 1,570 | 1·895 | 290 | Rotary transformer over-excited with 4·5 amps. (ammeter unsteady). |

The cost of the works was estimated by Mr. Stilgoe to be as follows:—

| | |
|---|---|
| Laying 3 miles 6·45 chains of single line with passing places ... ... ... ... ... | £15,600 |
| Electrical equipment ditto, including 8 motor and 2 trailer cars ... ... ... ... | 8,200 |
| Two car sheds and land ... ... ... ... | 3,000 |
| Electrical bonding ... ... ... ... | 900 |
| Total ... ... | £27,700 |

The normal exciting current of the converter at no-load is 2·5 amperes, at which excitation its power factor is nearly unity; but on the slightest alteration being made in the exciting current, the wattless (leading) component rises very quickly, and when the shunt coil resistance is short-circuited and the exciting current is 4·5 amperes, this component amounts to 280 to 300 amperes.

To make the effect of the converter as apparent as possible, a stationary transformer loaded with a single 65 H.P.

asynchronous motor was connected to the mains. For the second series of experiments (Table II.), two more 10 H.P. motors running light were switched in, hence the low power factor 0·41.

In each experiment the same phenomena recur. As the shunt resistance of the unloaded converter was gradually short-circuited, the current rose to about 300 amperes. At the same time the output of the generator in the central station altered, the volts rising from 2,000 to 2,200, while the flow of water in the driving turbine was unaltered. The output of the generator rose during this time from 3 kilowatts to 5 kilowatts, while the current diminished considerably, the number of revolutions of the turbine fell, and within 1½ minutes to 2 minutes stability was again reached, the pressure dropped again, but remained 25 to 50 volts higher than before, and the efficiency of the generator rose.

On diminishing the excitation of the rotary converter the order of events is reversed. The volts drop from 2,000 to 1,800 as the current increases, and the kilowatt meter shows a slight diminution of the output; and the former conditions are realised with a higher turbine speed, and a corresponding increase in the power expended for the excitation of the generator.

It appears from these experiments that an advantage was gained by over-exciting the rotary converter when running light during the daytime, especially if the power-factor is low as in cases II *a* and I *c*, where the currents from the generator had nearly reached the permissible limit at loads of 45 and 60 kilowatts.

By a judicious use of synchronous motors or rotary converters, according to circumstances, the outputs of generators at an alternating current central station can be considerably increased, or what amounts to the same thing, the required output can be obtained from machines of a lesser size, than if working on a purely inductive load.

## ELECTRIC LIGHTING NOTES.

(*Continued from page* 438.)

**Dover.** — When the question of lighting the front was before the Council last week, the Mayor explained that he had requested the Town Clerk to inform the Electricity Supply Company that the light would not be required after September 19th. They had already kept the front illuminated longer than last year. The company had also been asked to state whether they would keep the lamps up throughout the year in case illumination was required at any time, but the company had replied that this would be too costly. Last Sunday there was a failure of the light in some parts of the town, and the lamps on the front were lighted for the public convenience.

**Edinburgh.**—Last week the Electric Lighting Committee remitted to Prof. Kennedy to prepare a full report on a new electric light station near the east end of the city, as the accommodation in the present station is likely very soon to be exhausted. Since August 30th the number of applications for light is equal to 3,668 8-C.P. lamps.

**Fareham.**—Since the acquisition by the Urban District Council of the plant and powers of the Fareham Electric Lighting Company, a considerable improvement has been effected in the lighting of the main streets. The wooden poles have given place to iron columns, and for the overhead wires underground cables have been substituted. There is an increasing demand for the current for private lighting, and an installation of the Foresters' Hall has recently been completed.

**Folkestone.**—The Folkestone Electric Lighting Company have succeeded in obtaining a site from Earl Radnor, and it is anticipated that electric lighting works will be completed early in the new year.

**Glasgow.**—The Corporation Electricity Committee has purchased two sites on the north and south sides of the river for the erection of works for the supply of current to the city. We presume this is the outcome of the decision arrived at by the Corporation last week, after the discussion of the question of high *versus* low tension, the committee's proposal being sanctioned. The question of engaging someone to supervise the construction of the works was discussed by the committee, and there was a strong feeling that an electrical engineer should be engaged for several years exclusively for that purpose; but as feeling on the matter was pretty equally divided, it was thought better to consider the matter at another meeting.

Mr. Arthur Wright, of the Brighton Corporation Electricity Works, has written as follows to the *Glasgow Herald* on the subject recently under discussion at the Glasgow Council:—"Bailie Chisholm very correctly expressed, in his speech, my reasons for using the combination of low and high pressure systems there. When I state that only 100 horse-power out of the 5,000 being now installed in the Brighton station is to be used for the high tension distribution, there need be little doubt as to the system my past experience has led me to prefer for the distribution of electricity in densely-inhabited towns. Although only an engineer who has thoroughly studied the enormous Glasgow district over which electricity will soon have to be supplied for lighting, power, tramway, and other purposes, can state definitely whether the whole of it should be generated in two or three separate modern low tension stations or not, yet I have no hesitation in saying that a very great majority of the inhabitants ought certainly to have electricity supplied to them by means of low pressure continuous current, and that it is only by the concentration under one general committee of the whole business of electricity production and distribution that the best interests of the inhabitants of Glasgow will be served."

**Gravesend.**—The Works' Committee having gone into the question of electric lighting, reported in favour of the introduction of the electric light into the borough by Messrs. Crompton & Co., Limited, and the Electrical Supply Association, with which they were stated to be associated. When the matter came before the Council, an amendment disapproving of the minute was moved, but was lost by 10 votes to 4.

**Greenock.**—A Sub-Committee advised that with respect to the proposed electric lighting of Greenock, Port Glasgow, and Gourock, a deputation be appointed to collect information, and for that purpose to visit electric lighting installations in Scotland, also to employ an electrical engineer to advise as to the best means of utilising available motive powers for the generation of supply, and to prepare schemes and probable estimates. The Police Board, however, has only given the Sub-Committee power at present to report generally on the question of electric lighting.

**Hammersmith.**—We understand that the Vestry's electrical exhibition was opened at the Town Hall yesterday afternoon, and will last for several days. Practical demonstrations in heating, lighting and cooking are being given. Mr. H. J. Dowsing is responsible for these.

**Hornsey.**—The District Council last week decided to apply for a provisional order.

**Middlesbrough.**—The Electric Light Committee last week resolved upon the area of supply, and decided to recommend the appointment of Mr. Robert Hammond as electrical engineer.

**Morley.**—The Corporation want a jointer in connection with the electric light undertaking at £104 per annum. See our "Official Notices."

**Oldbury.**—The Council last week decided to apply for a provisional order.

**Paddington.**—The proposed electric lighting of Edgware Road by the Marylebone and Paddington Vestries, to which we referred briefly last week, will be done by 17 arc lamps, current being supplied by the Metropolitan Electric Supply Company. The terms will be similar to those charged by the company for the six lamps in Regent Street, viz., to lay mains, supply lamps and carbons; light, maintain, extinguish, &c., for a term of three years, for the sum of £30 per lamp per annum; the burning hours to be the same as those of the gas lamps, *i.e.*, 3,940; 17 standards at a cost of about £14 each; the total cost of installation, including standards, refuges, &c., would be about £400, so that each Vestry would have to pay, say, £200 for the installation, and £15 per lamp per annum.

**Peterborough.** — The Town Council vainly thought, when it had resolved not to further consider the electric lighting for 12 months, that its resolution was sufficient; but a private company has come along and forced the Council. Hence at last week's meeting of that body sitting in Committee, when the proposal of a company to purchase the provisional order came up for consideration, the matter had to be re-opened, and a report was submitted by the Borough Engineer, saying that an electric lighting scheme could be carried out with every prospect of financial success for £25,000, whereas a company was prepared to instal the light for £10,000. According to a Cambridge paper, the old opposition for which Peterborough Council has been conspicuous for the past few years on this electric lighting question is on "the waver," and there is a growing feeling in favour of municipal electric lighting.

**Rotherhithe.**—The Vestry will not consent to the proposed application by the County of London and Brush Provincial Company for a provisional order.

**Santiago.**—The *South American Journal* says that the Supreme Court had declared the agreement entered into with Parrish Brothers by the Municipality of Santiago, for the establishment of electric traction and lighting in the capital, to be null and void, in consequence of certain formalities not having been complied with. The decision of the Court was given on the application of a competitor of Parrish Brothers. To get over the difficulty caused by the Supreme Court, a Bill was presented to Congress to empower the Municipality to enter into a contract with Parrish Brothers in the terms of the agreement declared null and void by the Court, and it was promptly passed by both Houses.

**St. Pancras.**—The Electric Lighting Committee's report to be presented at Wednesday's Vestry meeting, shows that the net profit for the past half-year has been £499 14s. 5d. The amount expended on works was £191,314, of which £162,485 has been received on loan.

**Swindon.**—In view of the scheme for the amalgamation of Old and New Swindon, the New Swindon authorities desire to postpone the electric lighting proposal until that matter is settled.

**Train Lighting.**—Electric lighting is being tried on the West Coast express trains from London to Aberdeen.

A new vestibule train is to be put on the South Eastern Railway Company's regular main line service, the cars being illuminated by 8-C.P. incandescent lamps, the Gill system, by Messrs. Stone & Co., being employed.

**Walsall.**—The engineer is to prepare plans and specifications of additional plant required at the generating station for the ensuing year. He is also to go into the question of probable extensions of mains.

**Weston-super-Mare.**—The District Council has decided, by eight votes to seven, in favour of the electric lighting scheme submitted by Mr. Hawtayne, subject to certain important modifications.

**Wigan.**—The Gas and Electric Lighting Committee have resolved that they cannot recommend the Town Council to entertain any proposal for a transfer of the Wigan electric lighting order; "the subject of electric lighting is receiving the careful consideration of this Committee, who at the proper time will be prepared to submit to the Council proposals with regard to the intended installation."

## ELECTRIC TRACTION AND MOTIVE POWER NOTES.

**Bradford.**—The Tramways Committee have unanimously resolved to recommend the Corporation to adopt the overhead trolley system for proposed tramways to Horton and Bolton, and also to proceed with the work as soon as possible. A sub-committee inspected various provincial electric tramways before making its recommendation.

**Bristol.**—On Tuesday, the Eastville and Fishponds section of the electric tramways was opened, and luncheon was afterwards served at the Grand Hotel. The system, therefore, now extends from Old Market Street to Fishponds, and in a few weeks, when the Staple Hill section is completed, the total length of electrical line will be 8¾ miles. For this length there are to be 27 motor cars with six trailers running on ordinary weekdays, and 12 on Saturdays and Sundays.

**Central London Railway.**—Considerable fuss has been made with regard to the electrical equipment contract for this line going to the United States. As a matter of fact, however, we believe that no small part of the plant will be made in Berlin at the works of the Union Elektricitäts Gesellschaft; but although manufactured under a name of such repute, it may be doubted whether the patriots who wanted all the equipment to be turned out in this country, would not just as soon have bought it in the United States as Germany, if buying were necessary.

**Dover.**—The receipts from the electric tramways for the first six days were £155, and for the next six days £145. Wages to employés cost £24 a week. The receipts were considered very satisfactory by Councillors last week, especially as the Maxton line is not yet opened.

**Dublin.**—The electrical equipment of the double line from Annesley Bridge to Dollymount has been for some time completed, but, says the *Freeman's Journal*, it has not as yet been brought into requisition. The intention of the company was to postpone the opening of this electric line until a similar line from Annesley Bridge to the Pillar in O'Connell Street should be completed, which the Tramways Company have Parliamentary powers to carry out, but the details between the company and the Corporation have not yet been finally settled, though they are in a fair way of adjustment. If any undue delay with regard to the city section of the line should occur, and this is not anticipated, the Tramways Company are, it is stated, prepared to open the electric line from Annesley Bridge to Clontarf and Dollymount at an early date.

**Dundalk.**—The memorial of the Dundalk Electric Tramways Company for powers to construct a tramway line or lines within the parishes of Dundalk and Haggardstown has been sanctioned.

**Electricity in Gold Mining.**—It appears from a report from Consul Smuts on the trade of Swaziland during 1896, that the Piggs Peak Mining Company have a 30 stamp mill, worked by electricity, generated by water power. The ore has, however, proved refractory, and it has been found necessary to erect cyanide plant. This will shortly be completed, when an out-put from the company may be expected. The majority of mining syndicates or companies have done little or no work for some time. The Forbes Reef is the only one which shows an output of any dimensions. "During the year the company milled 21,913 tons, giving 1,288 ounces of gold, valued at £4,344. The company employed a 20-stamp mill worked by electricity, the dynamos being driven by a turbine, and owing to natural facilities, I understand that working expenses are low."

**Electric Power on the Rand.**—The undertaking of the Rand Central Electric Works Company which put down plant and extensive works in the neighbourhood of Johannesburg for the purpose of supplying current for lighting and power purposes to mines and other properties in the Rand district at about £45 per horse-power per annum, is generally described in the *African Review* for September 25th, 1897. Some illustrations are given of the power station which has been operating successfully for some months. The works are situated on the Rand coal fields, so in the matter of coal the company is favourably placed.

**Folkestone.**—It is said that a syndicate is endeavouring to establish electric tram cars in some of the Folkestone thoroughfares, and the local omnibus company has been approached to sell out its interest.

**France.**—La Compagnie Havraisè de Tramways Electriques is the title of a company which has just been formed at Havre with a capital of £60,000.

**Glasgow.**—We understand that the Tramways Committee after considering the effect of the Corporation's decision regarding the Lord Provost's amalgamation proposal, decided to proceed with their own scheme for the generation of electricity for the experimental Springburn route.

**Halifax.**—The work of laying the rails and preparing the track for the electric tramways has been in progress for the past month. The ceremony of laying the first length of rails in Horton Street was performed by Alderman Booth and Mr. Whitley (of the Tramway Committee) on 27th ult.

**Kidderminster.**—Mr. George Law, the contractor, is progressing favourably with the constructive works for the electric tramway between Kidderminster and Stourport. The tramway in Kidderminster, extending from the Short Heath to the Municipal Buildings, will be the first carried out, and then the line will be completed to Stourport.

**Liverpool.**—We understand that the Simplex Electric Conduit Syndicate has offered to lay down a two-mile length of tramway on its system, and to pay the entire cost, and to take it up again if it does not work to the entire satisfaction of the Corporation. The Tramways Committee recommend the Corporation to decline the offer.

**Middlesbrough.**—Mr. W. O. H. Baldwin, of the Westinghouse Electric Company, and Mr. W. W. Blunt, the company's engineer, inspected the route of the new electric tramways upon which work is progressing. It is understood that the Westinghouse Company has the contract for the equipment.

The Middlesbrough Streets Committee, after going into the question of the overhead wire work with Mr. Robinson, have agreed to 34 of the poles being placed in the centre of the street.

**Sheffield Corporation Tramways.**—We understand that Dr. John Hopkinson, F.R.S., will be asked to advise and report upon the tenders submitted to the Sheffield Corporation for equipment of the two experimental trolley lines in that city now about to be undertaken.

**Stourbridge.**—An attempt made at the last Council meeting to get rescinded the resolution passed at the previous meeting disapproving of the electric tramway proposals of the Dudley and District Light Railways promoters, was unsuccessful, six voting for the recision and eleven against, three remaining neutral.

**Torquay-Paignton.**—It is stated that the electric tramway scheme has been dropped until next May.

## TELEGRAPH AND TELEPHONE NOTES.

**Bermuda-Jamaica Cable.**—A company has been formed under the title of the "Direct West India Cable Company" for the purpose of connecting up the Islands of Bermuda, Turks Island and Jamaica by a cable which will afford to these latter islands a direct telegraphic route to Canada and Europe by means of the Halifax and Bermudas Company's cable and the different Atlantic lines. A contract for the manufacture and laying of this cable and also for the carrying out of a complete survey of the proposed route has been entered into with the Telegraph Construction and Maintenance Company, who have undertaken to complete the whole of the work by the end of the month of January next. Mr. H. A. Taylor, of the firm of Clark, Ford & Taylor, and Mr. R. E. Peake, have been appointed to act as engineers to the company for the purposes of the above contract.

**Birmingham Telephone Service.**—The expansion of business here has persuaded the National Telephone Company to erect a new exchange at the corner of Newhall Street and Edmund Street, in order to be prepared for further rapid growth of the local service. There are, we learn, at present 10 exchanges in the Birmingham district, and it is stated by a local paper that the company is considering the advisability of centralising these in one building. In the new building referred to, the second floor is mainly devoted to switch room and adjoining is the test room. The removal here takes place in a day or two. There are 2,000 subscribers, but the room will be sufficient to meet the requirements of 4,800 subscribers though at first the fittings in position will be only sufficient for 2,640. Mr. Alfred Coleman, the provincial superintendent, has his headquarters here, and Mr. A. E. Cotterill is the district manager.

## Telegraphic Interruptions and Repairs:—

| Cables. | Down. | Repaired. |
|---|---|---|
| Brest-St. Pierre (Anglo, 1869) | April 6th, 1893 ... | ... |
| West Indies— | | |
| St. Croix-Trinidad ... | Nov. 30th, 1896 ... | ... |
| Amazon Company's cable— | | |
| Parintins-Itacatiara ... | May 5th, 1896 ... | ... |
| Obidos-Parintins ... | Dec. 7th, 1896 ... | ... |
| Cyprus-Latakia ... ... | July 23rd, 1897 ... | Sept. 28th, 1897. |
| Bolama-Bissao ... ... | Sept. 13th, 1897 ... | ... |
| Hong-Kong-Macao ... ... | Sept. 28th, 1897 ... | ... |
| Cayenne-Pinheiro ... ... | Sept. 29th, 1897 ... | ... |
| Landlines. | | |
| Trans-Continental line beyond Mazol | March 12th, 1896 ... | ... |
| Carthagena - Barranquilla (Columbia) | July 4th, 1896 ... | ... |
| Saigon-Bangkok ... ... | Sept. 22nd, 1897 ... | Sept. 23rd, 1897. |
| " " ... ... | Sept. 24th, 1897 ... | Sept. 25th, 1897. |
| Siberian landlines— | | |
| Blagowestschensk Khabarowka | Sept. 27th, 1897 ... | Sept. 28th, 1897. |
| Guatemala landlines interrupted to Quazaltenango, Retalhulen, Ocos, Candelaria, Pouvenire, and all places West of Antigua | Sept. 17th, 1897 ... | |
| Nicaragua landlines ... ... | Sept. 21st, 1897 ... | Sept. 24th, 1897. |

**The Cable to Iceland.**—An article on this subject "from a correspondent" in Monday's *Times* gives the following information regarding this cable: In its last Session, July to August, 1897, the Icelandic Parliament decided to accept the offer of the Great Northern Telegraph Company in Copenhagen. This company undertakes to lay a submarine cable to Iceland from the North of Scotland *via* the Faröe Isles, provided the Althing, or Icelandic Parliament, grants an annual subsidy of 35,000 kroner for 20 years to the said company. The Althing has now granted this, and it is estimated that the cable can be laid early next summer in six weeks from Scotland to Iceland. The Danish Government has promised ample financial help and active co-operation in the scheme. The North Atlantic cable, which was discussed so widely 40 years ago, seems thus to be on the verge of its realisation. Lord Palmerston, in 1860, sent Captain (now Admiral Sir F. L. M'Clintock, in Her Majesty's ship *Bulldog*, to survey and sound the depths of the seas intervening between Scotland, the Faröes, Iceland, Greenland, and Hamilton Inlet in Labrador with a view to laying this cable. After five month's absence Captain M'Clintock came back and reported in favour of the scheme. At the same time the steamer *Fox* was sent by Mr. Croskey, of London, to examine the landing places for the cable. One may judge of the interest taken in the expedition by the fact that the Queen and the Prince Consort came on board the *Fox* at Southampton before she left. Some of the results of these two expeditions may now be said to have actual interest. The distance from the nearest point of Scotland to Thorshavn, in the Faröes, is about 250 miles, the greatest depth 254 fathoms, while the bottom is composed of *debris* of shells and mud. From Thorshavn the cable goes first either to Haldervig or Westmanshavn. The distance from the Faröes to Iceland is—according to the landing place selected in the last-named country—to Ingolfshöldi 280 miles, to Portland 350 miles, to Bernfjord 240 miles. The last named is the best landing place. The depth in this part averages a little under 300 fathoms. In one place only it is 680 fathoms. The bottom is composed of sand, *debris* of shells, and mud. Pumice was found in two places only. The temperature is 46° F. at a depth of 100 fathoms. When the cable is landed at Bernfjord, where the conditions are most favourable, it must be continued overland to Reykjavik. It must be laid north of the glacier plateau of Vatna Jökul. The following routes may be chosen: (1) *via* the Sprengisand, a distance of 250 miles; (2) close to the north of Vatna Jökul, 210 miles; (3) Across North Iceland, 310 miles. Lastly, the cable may be laid on sea bottom round the south coast of Iceland and round Cape Reykjancœs, a distance of 260 miles. The cable to Iceland will soon be a *fait accompli*. The growing trading and fishing interests of Great Britain in that country cannot fail to profit by it. Meteorologists in every country are looking forward to it with delight. England will not think twice before she uses Iceland as a link in her cable communication with British North America.

**The Freaks of Press Telegrams.**—Paris is not the only city in the world where telegraphic news takes wings unto itself and flies into the office of some newspaper other than that for which it was intended. The instance of the interception of *Times* telegrams in Paris will still be fresh in our readers' minds, and on account of its serious import is not likely to be forgotten for a long time to come. In the present disturbed state of India, we are hardly surprised at anything that occurs there, but we fail to see that that should be in any way responsible for a press telegram intended for *Indian Engineering* getting into the office and columns of a Calcutta daily. Such, however, appears to have actually been the case, and the matter is now in the hands of the Director-General of Telegraphs.

## CONTRACTS OPEN AND CLOSED.

### OPEN.

**Belize, British Honduras.**—October 20th. The District Board of Belize invite tenders for the lighting of the town by electricity. System proposed, "three wire or neutral wire," comprising boilers, engines, dynamos, accumulators, mains, &c. Particulars from Mr. A. R. M. Simkins, M.I.E.E., care of F. Otto, Esq., Tower Chambers, Moorgate Street, E.C. See "Official Notices," September 17th.

**Glasgow.**—October 20th. The Corporation want tenders for the electrical equipment of the Springburn and Mitchell Street route. Specification and particulars from Mr. John Young, general manager, 88, Renfield Street, Glasgow. See our "Official Notices" for further details.

**Hull.**—November 5th. The Corporation invite tenders for the electrical equipment of their tramways, to the extent of about 9 miles double track and ½ mile single track. The contract will not be divided and will include engines and generators, switchboards, feeders, poles, brackets, trolley wire, rail bonding and all accessories, also the first instalment of cars (15 motor cars and 5 trailers). City engineer, Mr. A. E. White. City electrical engineer, Mr. A. S. Barnard. See our "Official Notices" September 17th.

**Plymouth.**—October 2nd. Tenders are invited by the Corporation for overhead trolley line posts, brackets, tramcars, trucks, motors, trolley arms, &c., in connection with the borough electric tramways which are to be laid down. Borough electrical engineer, Mr. J. H. Rider. See our "Official Notices" September 17th.

**Queensland (Aus.).**—November 15th. The Municipal Council of Ipswich, Queensland, is inviting tenders for the supply and erection of the following electric lighting plant, &c.:—Tubular boilers, pipes, pumps and heaters, alternators and exciters, switchboard, high and low tension mains, junction boxes, transformers, &c. Specifications, and all particulars as to conditions, &c., may be obtained from Messrs. Gordon & Gotch, St. Bride Street, Ludgate Circus, London, E.C., and tenders have to be forwarded to the Town Clerk (Mr. Albion Hayne), Council Chambers, Ipswich, Queensland. See "Official Notices" September 17th.

**Roumania.**—November 15th. Tenders are being invited by the Municipal Authorities of Ploesti, for the concession for the establishment and working of an electricity generating station in the town, during a period of 40 years for private and public lighting and also for power transmission purposes.

**Russia.**—November 1st. The Municipal Authorities of Novorossisk, South Russia, are inviting tenders for the concession for the construction and working of an electric tramway and for the electric lighting of the town.

**Southampton.**—October 18th. The Corporation invite tenders for the supply and erection of engines and alternators, motor alternator, rectifiers and switchboards for high tension, engines and continuous current generators, balancing and volt-raising transformers and switchboard for low tension; accumulators and accessories. Consulting engineers, Messrs. Kincaid, Waller & Manville. See our "Official Notices" September 24th, for further particulars.

**Wakefield.**—October 2nd. The Corporation want tenders for the electric light wiring of the Town Hall. Particulars at the Town Clerk's office. See our "Official Notices" September 24th.

### CLOSED.

**Hampstead.**—The Vestry has accepted the tender of the Wigan Coal and Iron Company for the supply of coal to the electric lighting station for one year.

## GLASGOW TELEPHONE SERVICE.

Mr. Sheriff Jameson, on behalf of the Treasury, opened an inquiry in the Burgh Court Hall, on Tuesday, into the alleged defects of the Glasgow Telephone Exchange service. The National Telephone Company were represented by the Right Hon. J. B. Balfour, Q.C., M.P.; Mr. Charles Scott Dickson, Q.C., M.P.; Mr. Alexander Asher, Q.C., M.P., and Mr. John Wilson, advocate, instructed by Mr. William E. L. Gaine, general manager of the company, and Mr. James Andrew. Mr. Salvesen appeared for the Corporation of the City of Glasgow. The complainers were represented by Mr. Alex. Ure, Q.C., M.P., and Mr. R. T. Horne.

The Commissioner said that before entering on the inquiry there were a few general questions which he wished to put to the officials of the National Telephone Company.

Mr. W. E. L. Gaine, the general manager of the company, was then examined, and, under oath, said the Glasgow area was formed before he was appointed manager, but he thought it was in the early period of the 80's. The Telephone Company carried on business under a license from the Postmaster-General, as the business was in breach of the Postmaster-General's monopoly of telegraphs. The license would expire on December 31st, 1911. The license, which was granted in 1884, was unrestricted, and enabled them to carry on telephonic business generally throughout the United Kingdom, but under subse-

quent arrangements, made pursuant to the policy of the Government formulated in 1892, the company's general license of 1894 was now restricted to telephone areas throughout the country, the business of conducting telephonic business between the areas being resumed by the Postmaster-General by means of his trunk lines. With regard to the area in the Glasgow district, the number of lines was 6,625. Broadly, the rate was £10, with an £8 10s. subscription for each subsequent telephone.

Questions having been raised by Mr. Salveson as to the working and cost of the system,

The Commissioner said: I am doubtful whether we can go into the cost of the system. What I am to inquire into is whether the price charged is reasonable. A list of prices has been sent in which you can compare with the prices charged in other places, and by the Post Office itself, but I am not prepared at this moment to admit that you are entitled to get at the cost of working this system with a view of showing what profit they make, because that is what it would ultimately come to.

Mr. Salveson: The first thing I want to know is, how many of the wires are private wires.

Mr. Dane Sinclair, examined by the Commissioner, said he was engineer in Glasgow for seven or eight years, but he was now engineer-in-chief to the National Telephone Company over its entire territory. Of the 6,000 subscribers' lines, roughly speaking, something under 1,000 were private lines, the remainder being exchange lines. The Glasgow system included Dumbartonshire in two parts, Stirlingshire, Lanarkshire outside, Renfrewshire, and again round to Dumbartonshire. It included branch exchanges or sub-exchanges at Kirkintilloch, Milngavie, Bearsden, Clydebank, and Hillhead. The exchanges in the City were at the Royal Exchange, Douglas Street, South Side Exchange, and Bridgeton Exchange. The exchange at the Royal Exchange had by far the largest number of subscribers. About 3,200 subscribers' lines entered there, the total number being made up at the other exchanges. The business of the company had increased rapidly. When he joined in 1881 there were about 400 subscribers in Glasgow. After allowing for those who had ceased to be members, the increase in lines each year since 1890 had been as follows:—1890, 722; 1891, 873; 1892, 404; 1893, 287; 1894, 354; 1895, 469; 1896, 401—total increase, 3,450. In addition to the ordinary business, there was the business on the trunk lines done through the Post Office, for which an additional charge was made. There were also junction wires apart from the trunk lines, for which no extra charge was made. He explained the system of working at the Royal Exchange, to which each subscriber had his own wire for his sole use. In addition to this, he had the use of a call wire divided among a number of subscribers ranging from 30 to 60, 50 being the number considered to be the right number on any one call wire. An operator sat listening at the call wire all day. It was true that on a call wire two subscribers, or three or four out of 50, might wish to speak at the same time, and people could, if they wished, create confusion from that cause. But it was found in practice that while there were some people who liked to create confusion, the majority dealt with the matter in a business way, and gave way to each other, and so the operator was allowed to take the calls in order, and do the necessary work. The call-wire system had one point of advantage, which was that the subscriber could, of course, easily estimate the time which was taken in replying to him. The number of wires from each branch exchange was dependent on the number of subscribers who used them.

By Mr. Salvesen: There were 44 call offices in the city and suburbs.

Mr. Andrew Kufeke, grain merchant, Hope Street, examined by Mr. Ure, said he was a member of the Corn Trade Association. He had been a subscriber to the Telephone Company since the beginning, and paid £10 annually. He had had occasion to make innumerable complaints about the non-efficiency of the service. In a general way he regarded the whole system as a nuisance. The noises were so great that he could not make himself understood, and then there was the difficulty of getting connected. When he wished to get connected, he was told that somebody was engaged. Members of his firm had rung up from other places, and could not get connected with him, because, it was alleged, that he was engaged. Coming back to the office they complained of this, and he knew that at the time at which connection was sought he had not been engaged anywhere. That did not occur very often. It would occur once a week or once a month. He had heard other voices through the wires besides the man with whom he was conversing, and had heard that there were cheaper sellers than he in the market. The conversation was so distinct that he heard what was going on. To his surprise he had heard four or five people speaking at the same time, and very often they were competitors in trade. If he heard other people through the wire, they would naturally hear him. He had very often been rung off before the man with whom he was in communication had ceased speaking. He believed the Corporation would work the service cheaper and more efficiently than the company. The company had in the first place to consider their shareholders. Their business was to pay good dividends, irrespective of what the business was or was not. The Corporation would be in a better way to serve customers, because it was a question of public benefit.

In cross-examination by Mr. Asher, the witness said he did not remember when the telephone was first introduced, but it was, he thought, during the 80's. He found it important and of great convenience to have the telephone to communicate with his customers.

He considered it a nuisance to try to do business and be baulked by the rumbling of the instrument and being unabled to get connected. He had continued to use the telephone because he could not do without it. If he took the instrument off, the loss would be greater; there was a loss now. The telephone was convenient only when it was a perfect system. He found it a nuisance in the use.

He could speak of telephones he had used in America, in England, and on the Continent, where they are perfect. He had used them in his Liverpool office, where he thought the wires belonged to the same company. He would give double the subscription if he could have a good service. The efficiency of the service is much more important than the price.

Asked if he was not entitled under the arrangement with the company to speak to every one of the 100,000 subscribers in the Telephone Directory; whether he considered that dear? He considered it dear if he could get a better service for half the money. He based his argument for a Corporation service on the fact that the company have to consider the shareholders' dividend. The original capital of the Telephone Company had been largely watered down, so that they have to provide an income for a very much larger sum than they had originally, for which they have to show no assets. If the Corporation had the telephone they would certainly, in the first place, try to serve their customers and the public in general, and to bring business to the city, irrespective of whether a profit or a loss was made.

He certainly would prefer to have the whole affair in the hands of the Government, but next to that the Corporation would be the best.

Asked if he would not like to have to subscribe to two systems in Glasgow, he said he would rather have one, certainly.

By Mr. Ure: You do not complain on the company's printed form every time the telephone is deficient?—We ceased complaining, because we got disgusted. We gave it up as a bad job. He did not want to be unjust to the company. He had not used the telephone in other countries for years, as he had done in Glasgow, but had found it a great convenience in all sorts of places, hotels, and so on, in Germany, in Hungary, and in France.

The Commissioner: Has the noise or buzzing of which you have complained increased or diminished of late years?—It is as bad now as ever it was.

How often in the course of a year have you had to desist on this account?—It has been very frequent. Certainly very much oftener than twice. I remember lately I tried to speak from Cranston Hill to my office, less than a mile distant, but I had to throw it up because I found it was no use after I had tried for a minute or two.

On what date was it when the incident occurred of some of your people failing to get connected and their being told that the wire was engaged when that was not the case?—I can't give the date; it is impossible. The complaint ranges over a number of years, and has happened many times.

It was a very serious case of fault on the part of the Telephone Company if they failed to put you in connection, and told the persons who wanted to be put in connection with you that you were engaged when you were not engaged; it was a very serious fault on the part of the Exchange. Did you not on those occasions when you were sure of your ground make a formal complaint to the company?—I complained, but, as I have explained, I have given up complaining.

Did you ever make a complaint of an incident of that particular kind?—That I can't say.

Mr. John Muir Paton, of the firm of Messrs. Paton and Henry, shipowners and brokers, Oswald Street, said they managed 30 steamers and had a large chartering business. They had been subscribers to the telephone for seven or eight years, during three of which they had had two instruments, only giving up the use of the second one about a year ago.

Mr. Ure: What have you to say about the telephone?—We gave up the second telephone because we could not get the thing to work satisfactorily. It was a regular nuisance.

Witness said he had written numerous letters to the company containing complaints. When speaking to customers he had been unceremoniously cut off, and often there was a buzzing sound, which made conversation impossible. In consequence of the defects he had very often suffered a serious business loss. He then gave instances in which, when he and his partner knew that no one was using the telephone the Exchange had said that the wire was engaged. In reply to a complaint on the subject, the company said that there was a fault in the instrument which caused this result; but there was no improvement afterwards. After complaints had been made, matters might be a little better from time to time, but they got as bad as ever afterwards. A very serious complaint was that it was impossible to hold a private conversation on the telephone as it was worked now, because others were continually put on, and he had to ring off and send messengers to his clients. He had sometimes to wait an hour before getting connected. The delay was a frequent cause of complaint. He was in favour of a change in the telephone system. If the Corporation got a license, the service could not be worse, however much better it might be. One day he tried to speak to Irvine but could not, but his partner spoke from Liverpool and he could hear quite easily. He could not do without his single telephone, even though it was occasionally a nuisance. When acting effectively, it was a great convenience for his business. What he complained of was that it was so frequently ineffective. Witness read a letter received by his firm yesterday morning, in which their clients said:—"It is most appalling the number of times we have rung you up last two months by telephone. The Exchange people cannot explain, and neither can we, since the bell seems to ring sufficiently. On account of this, we are obliged to forward our traffic by other routes. Please explain." This was a complaint such as his firm frequently received. His firm did not complain to the company unless it was something exceptionally glaring. The thing got so chronic.

Mr. Asher: If you spoke to Liverpool all right, and could not speak to Irvine on the same day, does that not show that the defect was not in your instrument nor in the wire to the Exchange, but in the trunk connection between Irvine and Glasgow?—Yes, I dare say. In further cross-examination, Witness said he had spoken to a party this morning, and in about a minute, a second and then a third party were put on.

Mr. Ure: I call your attention to a letter addressed by your firm to the Telephone Company, in which you say: "Your chief inspector was here to-day and overhauled our instrument, but we regret to say there is no improvement." I ask you whether it is a fact that after the inspector called the instrument was better for a short time, and then became as bad as ever?—Yes, that is a fair instance of what

occurred on every occasion when the company sent their men to our premises.

The Commissioner: Have you anything to say about the prices charged?—We would take two instruments if the price was £5, but if the system was good we would have no objection to take another at £10. The price is not so important as a good service.

Mr. John Macdougall, secretary of the Corn Trade Association, being examined by Mr. Ure, said that all the principal corn merchants were members. About 10 days ago the executive considered the question of the telephone service. They were unanimous in expressing dissatisfaction with the present system, and were in favour of the Government taking the telephones into their own hands, as they had at present the trunk lines. Failing this, the Corporation was approved of. The matter was not in any formal way submitted to the Association. The executive did not take action of their own motion, but considered a letter received by them from Messrs. Wright, Johnson & Mackenzie, as representing a committee of subscribers.

Mr. Asher said that one of the witnesses he proposed to call was Mr. Paul Rottenburg, chairman of the Chamber of Commerce, and he would produce a resolution with reference to the present question. He attended in his individual capacity.

The Commissioner said he had received from the secretary of the Chamber of Commerce a letter, dated September 3rd, communicating a resolution of the Chamber. At a special meeting 14 votes were given in favour of the Corporation of Glasgow in their application for a license to establish a municipal service, and 40 votes in favour of the following motion, viz.:—"In the opinion of this Chamber it is desirable that the telephone system should be taken over by Her Majesty's Government as part of the postal telegraph service of the country." The clerk to the Commission wrote to the secretary of the Chamber of Commerce to the effect that it might be desirable that he should appear to speak to the resolution and also for the Chamber, but that gentleman apparently did not desire to do so. The Commissioner informed him that if he did not attend, the letter would be filed as part of the documentary evidence in the inquiry.

Mr. J. H. Carruthers, senior partner of Messrs. J. H. Carruthers and Co., Polmadie Ironworks, replying to Mr. Ure, said that they had two telephones—one in the works and one in his house—through the works, for which they paid £22. They had been subscribers since 1890. The service had been inefficient all along. Since 1893 they kept a record of the complaints they had had to make. In all there had been 114, in addition to a large number of daily complaints. These consisted for the most part of difficulty in getting connected, being put on numbers which they did not want, being told that persons were engaged when they believed they were not so, and indistinctness. When they happened to get hold of the chief operator they were connected soon enough. Other voices were heard when conversing with a customer, so much so that they did not care about giving a quotation by wire. Asked whether his complaints had resulted in the cause being removed witness said that the visits of the officials were very superficial. The telephone seemed to have as many complaints as the human frame is subject to. No sooner is one thing cured than another crops up. They had more cause for complaint some time ago than recently. An efficient telephone was a very essential thing now; they could not do without it. He had no complaint about the charge, but they had claimed deductions in consequence of inefficiency. The claiming of money deductions was the only hold which they felt they had upon the company. The majority of the complaints related more to the condition of the line than to failure to get connection, therefore it seemed to him that an underground system would obviate the cause of this complaint. The occasions upon which they failed to get connection were not very rare. It was a daily occurrence to receive the reply "Engaged." It might be true in a great many cases, but they were strongly of opinion that in others it was not true. It was perfectly possible and probable in the working of the telephone that another subscriber might be in communication with a person they wished to be connected with at the time. The cases for complaint would be when the other person's wire was when you asked, "connected," and you did not get it; but when the answer "engaged" was repeated over and over again for half or three-quarters of an hour, one began to be suspicious. Very often they knew the nature of the business of their correspondents, and that they could not have been engaged at certain times. When they did get a connection, they occasionally asked the person if they had been engaged at the particular time in question, and were told that they were not engaged. One gentleman had not been engaged, and there was no reason why he should not have got connected. He did not think he might have forgotten to switch off, as he was a very careful man.

Robert M'Callum, President of the House Factors of Glasgow, said that on Thursday, September 9th, a meeting of his council had passed the following resolutions:—"(1) The council of the association, while having no special means of knowing what are the defects of the present telephone system over and above ordinary subscribers, are aware that there have been a considerable number of complaints as to the cost and efficiency of the present system: (2) they are of opinion that in the interests of the owners of property it would be an improvement if the wires were placed underground. A considerable amount of damage is done to roofs by men going on them constantly to attend to the posts and wires, and although the Telephone Company bore the cost of repairs where actual attachments exist, men are constantly passing along; (3) if the wires are put underground, they desire that they should be put under the street and not under the foot pavement; the pavement is maintained by the proprietor, and there is already too much breaking up of the pavement; and (4) they express no opinion as to the best method of effecting a change, whether by the present company, a new company, or the Corporation." The wires to his branch offices were often broken, and they lost the use of the telephone for over a week.

If the wires were put underground the company would be able to supply the service at a cheaper rate, because they would not have to keep up the roofs. What he desired was to have the telephone at a cheaper rate.

Prof. Murdoch Cameron said he had been a subscriber for eight or ten years, and that he had had cause of complaint during all that period. Sometimes his instrument would not go for a week at a time. He had complained personally at the General Exchange. The telephone had become such a nuisance that many of the profession talked of giving it up altogether. On a wet day his bell would be ringing all day long whether he wanted anyone or not. He thought that a remedy for present defects would be to put the wires underground. He had had experience of the telephone in Sweden recently. It was not characterised by the defects which were experienced in Glasgow. It might be put all right if the wires were put underground and a metallic circuit adopted if there was a penalty clause upon the operators. He found the operators very attentive.

Mr. David Clarkson, grain merchant, partner of Messrs. Petersen and Co., Waterloo Street, said they were original subscribers. They had three instruments, for which they paid £17 2s. The system was altogether inefficient. They were so disgusted that they had asked the company to take away the instruments. Matters were getting worse. His view was that one cause of defect was that the operators were overworked. He believed that the answer was frequently given that a wire was engaged when it was not the case. He gave an instance in which he had endeavoured to get Messrs. Macfarlane, Lang & Co. all one afternoon without being able to do so. He knew that they could not be engaged all that time. If the system were efficient he would not grudge the price which he paid.

Mr. James Forsyth, of the United Operative Baking Society, Ltd., said that they had been subscribers for 10 years. They had two exchange wires and four private wires, for which £48 17s. was paid. The service was very bad. Out of the five wires, four had been useless since the 23rd inst. The directors of the society had expressed themselves in favour of the Corporation taking over the telephone, because they thought they would get a very much better service. They had the instance of the tramways. The public there had got a great advantage; they had cheaper fares, and they had the satisfaction of seeing the servants paid better wages. The telephone service was very much disturbed by wind and lightning storms. The best course would be to put the lines under the street. According to his experience, the telephone was about as often ineffective as it was effective. His view was, that there was something wrong in the Exchange. If the Corporation were to give a £5 system instead of a £10 one, he believed that business men would become subscribers. It was suggested that there should be a common switch-room for use in connection with both systems.

Mr. Alexander Rutherford, accountant, Secretary Glasgow and West of Scotland Guardian Society for the Protection of Trade, said that the telephone system required very great improvement, as it was defective and ineffective. He became a subscriber in 1887, and after four years ceased to become so because he found that it did not meet his requirements. He made frequent complaint, but without effect. He had again become a subscriber. He did so in 1896. He found the system practically what it was before. He got very little good from it. It was useful enough for making appointments, but not for holding continuous conversations, on account of the frequent interruptions. There were noises, great difficulty was experienced in getting connected, and they could always hear people speaking. The bell was often ringing when not required. It would not be a suitable service if there was no communication with the suburbs and police burghs round about. He did not see why the Corporation should not communicate with the outside. Efficient service was what he wanted, rather than reduced rate. In the event of the Corporation obtaining a license, and giving an efficient service, he would be disposed to support them, and it would be a good thing for the city.

The inquiry was adjourned until Wednesday morning.

On Wednesday the Secretary of the Building Trades Exchange stated that at a general meeting of the members of the Exchange a resolution was passed expressing dissatisfaction with the telephone service, that it was too costly, and that the attention on the part of the company's servants was unsatisfactory.

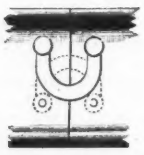
Mr. Joseph Maclay, a shipbroker, gave it as his opinion that it would be better to place the telephones in the hands of the corporation, because it had done very well in everything it had taken up. Mr. J. B. Fleming, of Kelvinside, said he gave the telephone company a good wire which cost him £200 to erect, and he paid £28 10s. for two telephones. He had made frequent complaints as to the inefficiency of the service and the want of attention on the part of the staff. He only got 1s. worth for every £1 he paid. It was impossible for a man, unless he had the patience of Job, to stand the intolerable nuisance of the telephone. He knew of no subscriber who was satisfied. He wished the Government to step in and acquire the telephone.

Mr. John Raeside, a yarn agent, said any change in the telephone system would be better than the present. He would be glad if the Corporation would take it up, but he would prefer the Government to do so. The present company were simply throttling telephonic connection in Glasgow—he did not say willingly, but they had done so. There ought to be four times the subscribers there were at present. Attempts to start any exchange had either been bought up by the National Company or threatened with legal proceedings; in consequence they had to desist. In regard to the instruments, those which the company used were very inferior. When he was using his own wire he had the Ericsson, a very sensitive instrument. These instruments were simply connected to a certain other instrument with a single wire, which could not possibly come in contact with any other wire. That would, to a certain extent, account for hearing so well. The Ericsson was very much superior to that in use by the telephone company. The National Company made him give up the use of them, alleging that he was infringing their patent. It was a case of putting down everything which was better than their own.

The inquiry was adjourned.

## NOTES.

**Rail Bonding in Brooklyn.**—The Brooklyn Heights Railroad Company has, according to the *Street Railway Journal*, devoted a great deal of attention to the proper bonding of track, and has tested and experimented with a large number of different types of bonds. As a result, the company is using principally this year for its angle plate joints the Atkinson rail bond. Two No. 0000 bonds are used at each joint under the angle plate, one on each side of the web, as shown in the accompanying engraving. The



distance between bond holes is 3¼ inches. The rails are cross-connected every 500 feet by means of plates soldered to the rail webs and joined by a 500,000 cm. cable. One or more cables are also run under all special work, connecting the straight rails. Overhead return feeders of the same size are used in the lower part of the city. The company last year installed 2,000 Falk joints, and is well satisfied with them. No bonds are used with these joints.

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**A Modern Motor Installation.**—The Farrel Foundry and Machine Company have adopted motors for driving their machinery, and the works are described by our American contemporary, the *Electrical Review*. The Farrel Foundry is at Ansonia, and the water-power which drives it is three miles distant, at the Housatonic Dam, belonging to the Derby Gas Company. There are two dynamos coupled in series, and yielding current at 1,100 volts. These machines are of four-pole 200-kw. 550 volts, and when the current arrives at Ansonia it has a pressure of 1,000 volts, and is distributed on the three-wire system, with half the motors on each side. The working pressure is thus 500 volts. The water-power is used for 10 months of the year; power for the other two months —which, we presume, are months of frost—being obtained from steam-driven plant. The motors are of the following size :—

| No. | | H.P. | | Speed. |
|---|---|---|---|---|
| 3 | ..... | 35 | . ... | 525 |
| 5 | .. ... | 10 | ..... | 325 |
| 3 | ..... | 15 | .. ... | 312 |

They are all of four-pole type, and mostly placed on platforms suspended from the roof girders, belts being taken to shafting below from which the machinery is driven. The Farrel Company make ore and rock crushers, and heavy rolls for rubber manufacture, so that loads are heavy and fluctuate over a wide range, but for 18 months no repairs, either to generators or motors, have been required. In regard to economy, it is worth mentioning that there was formerly an engine of 250 H.P., and this was loaded to its full capacity, but the machinery is now driven by motors of from 125 to 150 horse-power. In addition to the machinery named, a steam-driven generator of 65-kw. 250 volts, supplies current to three travellers and several jib cranes. This machine gives no trouble from sparking despite the widely varying duty it is called on to perform. The General Electric Company, of Schenectady, furnished all the electrical plant, and it would appear that the economy must be from 33 to 50 per cent. in power.

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**Another Sale of Apparatus for England.**—The N.Y. *Electrical Engineer* just to hand contains the following interesting piece of information:—The Westinghouse Electric and Manufacturing Company has received from its European company notice of the award to it by the Metropolitan Electrical Supply Company of the contract for a large electric lighting plant to be installed for London. The apparatus will be of the multiphase type, involving the use of the Tesla patents, which are owned in England by the Westinghouse Company. It is understood that the contract amounts to between $350,000 and $400,000.

**Globular Lightning.**—According to the *Zeit. f. Elektrotechnik*, August 15th, this unusual and interesting phenomenon was observed at the watering place, Szliács, on May 25th. About noon on that day a violent thunderstorm broke over Szliács. At 2.45 a ball of lightning about the size of a man's head was seen to descend, and float about 6 feet above the ground. It whizzed past the stair railings of the "Villa Buda," throwing a workman who was standing near against the pillars which support the steps. It then passed through an open window into a room on the ground floor, passed within a few paces of the bath superintendent sitting at a table, and close by a porter standing in the room, then out into the open again through a closed window, in which it cut a hole about the size of a fist. When outside the lightning ball ran against a poplar standing 15 paces in front of the building. From this it tore off the bark and wood to a depth of 2 cm., a breadth of 20 cm., up to a height of 10 metres, whence it descended on the other side to the earth, leaving behind it a narrow channel. The detonation which accompanied the lightning was not louder than the report of a gun. Nobody was injured. Another case is reported from Nioheim, in Prussia. A lightning discharge, accompanied by crashing thunder resembling the discharge of a mass of broken glass on the pavement, struck a farmhouse near the station. The following peculiarities in the appearance of the lightning were noted by six eye witnesses. It descended from the cloud to the outside of the chimney in the form of a ball, about the size of a cannon ball. After the ball was an interval of 1—1½ metres, then a sheaf of fire of 1—2 m. in length. The ball appeared to be accompanied by a short sharp report, while the crashing thunder appeared to be due to the fire sheaf.

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**Personal.**—Mr. G. H. Bailey, who for 12 years has been connected with the Silvertown Company's cable staff, both on the engineering and electrical branches, and who was associated with Mr. J. Rymer-Jones in duplexing the Central and South American and Western and Brazilian Telegraph Companies cables, and was for some time in charge of the South American Cable Company's affairs in Pernambuco, has joined the African Association, Limited, and leaves Liverpool for a coffee plantation some 15 miles up country from old Calabar, West Coast of Africa, on October 9th next. We understand Mr. Bailey takes a special letter from the Foreign Office to Sir Ralph Rayment Moor, K.C.M.G., H.M. Commissioner and Consul-General for the Niger Coast Protectorate, as Her Majesty's Government desire to give all possible encouragement to cultivation of suitable produce which will provide regular employment for the natives, and increase the trade of the country generally. Mr. Bailey goes out to prepare himself to take charge of a plantation next June, and desires his numerous telegraph friends in many parts of the world to know that his address will be Iko Tombo Plantation, Old Calabar, West Coast of Africa.

Mr. Humphrey, who up to the present has been in charge of the electrical department of the Great Western Railway at Cardiff, has been appointed to a similar post at Worcester by the same company.

Mr. H. C. Marillier notifies his removal from Rossetti Mansions, Chelsea, to Kelmscott House, Upper Mall, Hammersmith.

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**Testing Electricity Meters.**—From an "Official Notice" appearing in this issue, particulars may be obtained of the scale of fees to be imposed by the London County Council (subject to the approval of the Board of Trade) for testing electricity meters, testing pressure on consumers' premises, service lines, complete installations. As will be seen from the notice, anyone objecting to the proposed fees may do so by letter addressed to the Board of Trade within a month.

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**Lectures.**—Mr. J. Gavey, of the G.P.O., delivered an address on Saturday last on "Wireless Telegraphy" at the opening meeting of the Upper Holloway Centre of the London Society for the extension of University teaching.

"The Story of the Electric Current" was the subject of a lecture given to the students of the Hyde Mechanics Institute on 15th ult. by Mr. T. Seaston.

**Mica.**—The *Engineering and Mining Journal* abstracts an article which recently appeared in the *Indian Agriculturist* on mica in Behar, India, in which it is stated that the better qualities of mica are exported to England and the United States, while the lower grades are used locally for making small lamps for the marriage processions of the richer Hindus. White mica is rare in Behar, the best Indian mica being ruby coloured. Although mica mining is sometimes very unprofitable, on account of there being no certain surface indications of its presence, trading in it is said to be very lucrative. The present mica mines are all situated in the districts of Hazaribagh and Gya. The mineral is also found in certain parts of Manbhoom, but all attempts to work these mines profitably have hitherto failed. The principal mines in the Hazaribagh district are Dumcho Gharanchi, Bochagta, Salboya and Kodama. In Gya the mines worked are Singur, Vita, Chatkari, Bind, Govindpore and Korarama. The Government leases out land at a fixed rate of Rs. 50 per acre, while private lands are leased by arrangement. When brought out, the mica yields easily separable layers, the uppermost of which are generally cracked, and therefore useless. The lower layers are sent to Calcutta, either in blocks, or after being cut and sorted. The largest pieces are about 25 inches long and 5 inches wide. Unstained, good ruby-coloured mica realises as much as Rs. 800 per maund (maund = 80 lbs.), but even higher prices have been reached. One specimen from Gya sold last year for Rs. 1,600 per maund. There is only one mine, Singur, in Bengal, which yields white mica, and this has been worked for 30 years. It is stated that mica trading would be even more profitable if the trader, instead of buying in Calcutta, went direct to the mines to purchase.

**Water Power in the States.**—According to a *Times* telegram, the formal opening of the new works for the utilisation of the Lachine Rapids for furnishing current to Montreal and other municipalities for lighting and power purposes were formally opened on 25th inst.

**Obituary.**—We regret to learn that Mr. M. H. Wilhelm, who has been seriously ill for some time, has just died of consumption. The business of Wilhelm & Co. will be continued at Westmoreland Buildings, Aldersgate Street, under the same style and conditions, by Mr. H. Haldmaier.

**City and Guilds of London Institute.**—The new session at the Finsbury Technical College commences on Monday next, October 4th. See our "Official Notices."

## NEW COMPANIES REGISTERED.

**Bromley (Kent) Electric Light and Power Company, Limited** (54,127).—Registered September 21st with capital £20,000, in £5 shares, to carry on the business of electrical engineers, electricians, contractors, suppliers of electricity, and electrical apparatus manufacturers. The subscribers (with one share each) are:—R. Taylor, 115, High Street, Bromley, Kent, jeweller; J. Uridge, 15, Widmor Road, Bromley, Kent, grocer; F. Medhurst, 50, High Street, Bromley, Kent, draper; G. H. Cakebread, 79, Widmore Road, Bromley, Kent, merchant; W. R. Bassett, 19, East Street, Bromley, Kent, printer; F. E. Gripper, Clifton Villa, East Twickenham, engineer; J. King, 40, West Street, Bromley, Kent, clerk. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first. Qualification 20 shares; remuneration as fixed by the company. Registered by Todd & Co., 22, Chancery Lane, W.C.

**Pullin & Shore, Limited** (54,130).—Registered September 21st with capital £10,000 in £1 shares, to acquire and carry on the business of electrical and general engineers, carried on by E. Pullin and C. Shore, at Bolton, Lancashire, as "Pullin & Shore." The subscribers (with one share each) are:—J. E. Pullin, 148, Radcliffe Road, Bolton, electrical engineer; C. Shore, 10, Bury New Road, Bolton, electrical engineer; J. W. Gunshaw, 17, Dellar Street, Spotland, Rochdale, cashier; C. Heap, Caldershaw, Rochdale, dyer; Mrs. M. E. Heap, Caldershaw, Rochdale, dyer; F. Shore, 4, Court Street, Bolton, electrician; J. S. Hudson, 31, Scarisbrick New Road, Southport, gentleman. The number of directors is not to be less than two nor more than five; the first are J. E. Pullin and C. Shore (managing directors), with £156 each per annum. Registered by G. Trenam, 7, New Court, W.C.

**Electrical Vehicle Syndicate, Limited** (54,135).—Registered September 21st, with capital £25,000 in £1 shares, to further and develop the use of electricity in connection with traction, and to carry on the business of electrical engineers, manufacturers and proprietors of electrical vehicles, metal workers, contractors, &c. The subscribers (with one share each) are: F. T. Medcalf, South Hill, Bromley, Kent, gent.; L. W. Shepheard, Riverside, Mortlake, S.W., solicitor; S. Jordan, 13, Callow Street, Chelsea, gent.; W. F. Smart, 25, Spenser Road, Herne Hill, S.E., gent.; J. R. Marriott, Kibworth, Leicester, gent.; A. W. N. Stuart, 10, Aubert Park, Highbury, accountant; T. J. Bowles, 27, Upper Marylebone Street, W., gent. Table A. mainly applies. Registered by Deacon & Co., 9, Great St. Helens, E.C.

## CITY NOTES.

### Willans & Robinson, Limited.

The accounts for the half-year ended June 30th, 1897, are to be submitted at the ordinary general meeting, to be held at the Victoria Works, Rugby, at 3.30 p.m., on Wednesday, October 6th. The directors state that, "After writing off as depreciation from plant, patents, &c., the sum of £4,162 11s. 2d., and paying interest upon debenture stock, the balance to the credit of profit and loss account for the half-year (including £2,052 9s. 6d. brought forward) is £13,549 0s. 6d. Out of this the directors propose that dividends be paid at the full rate of 6 per cent. per annum upon the preference shares, and at 7 per cent. per annum upon the ordinary shares, together amounting to £7,486 5s. 2d. The amount payable to the directors, in accordance with the articles of association, is £1,203 1s. 9d., leaving a balance of £4,859 13s. 7d. From this the directors propose to carry £2,000 to the debenture redemption fund, and £1,000 to the reserve fund, as before, leaving a balance of £1,859 13s. 7d. to be carried forward. The directors feel that they may congratulate the shareholders upon the result of the half-year's trading, which enables them not only to propose the usual dividend, but also to make the usual reserves, notwithstanding the great interruption to business, due to the move from Thames Ditton. The interruption has been the more serious, owing to the further extension of the shops put in hand last spring, which has kept the works in an unfinished state, and will necessarily continue to do so throughout the current half-year. It is probable that it will be found desirable, in the course of next spring, to arrange for the issue of the balance of the capital authorised by the resolution of February 22nd, 1897."

**British Columbia Electric Railway Company Limited.**—It is notified to the holders of such part of the scrip of the British Columbia Electric Railway Company, Limited, 4½ per cent. first mortgage debentures represented by provisional certificates to bearer, that the same can be lodged at the office of the company's agents, Messrs. Sperling & Co., 8, Austinfriars, London, E.C., on and after October 4th, between the hours of 11 and 2 (Saturdays excepted), to be exchanged for the definitive bonds. Scrip must be listed in numerical order, and lodged three clear days for examination.

**Salt Lake and Ogden Gas and Electric Light Company of Utah.**—The Gas, Water and General Investment Trust, Limited, is advised from New York that, for the purpose of the consolidation scheme, the few outstanding bonds must be lodged at its offices, or with Messrs. Sullivan & Cromwell, of 45, Wall Street, New York, on or before October 15th next. Bonds lodged after that date will be subject to a charge to be hereafter fixed, and are liable to exclusion from the benefits of the scheme.

**Stock Exchange Notice.**—The Stock Exchange Committee has ordered the under-mentioned to be quoted in the Official List:—Westminster Electric Supply Corporation, Limited: Further issue of 12,000 ordinary shares, Nos. 68,001 to 80,000.

**Reuter's Telegram Company, Limited.**—The directors have declared an interim dividend at the rate of 5 per cent. per annum, free of income-tax, for the half-year ended June 30th last. The warrants will be payable on 9th prox.

**Metropolitan Electric Supply Company, Limited.**—The transfer registers will be closed from 4th to 11th prox., both days inclusive, for payment of an interim dividend on the ordinary shares numbered 101 to 50,000, inclusive.

**Eastern Extension Telegraph Company, Limited.**—The directors have declared an interim dividend for the quarter ended June 30th last of 2s. 6d. per share, free of income-tax, payable on 15th prox.

## TRAFFIC RECEIPTS.

**The City and South London Railway Company.** The receipts for the week ending September 26th, 1897, were £891; week ending September 27th, 1896, £925; decrease, £34; total receipts for half-year, 1897, £11,094; corresponding period, 1896, £11,813; decrease, £119.

The Cuba Submarine Telegraph Company. The traffic receipts for the month of June were £3,288, as compared with £5,179 in the corresponding month of last year.

**The Liverpool Overhead Railway Company.** The receipts for the week ending September 29th, 1897, amounted to £1,407; corresponding week last year, £1,168; increase, £239.

**The Western and Brazilian Telegraph Company, Limited.** The receipts for the week ending September 24th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,737.

## SHARE LIST OF ELECTRICAL COMPANIES.

### TELEGRAPH AND TELEPHONE COMPANIES.

| Present Issue. | NAME. | Stock or Share. ‡ | Dividends for the last three years. 1894. | 1895. | 1896. | Closing Quotation, Sept 22nd. | Closing Quotation, Sept. 29th. | Business done during week ended Sept. 29th, 1897. Highest. | Lowest. |
|---|---|---|---|---|---|---|---|---|---|
| 149,900£ | African Direct Teleg., Ltd., 4 % Deb. | 100 | 4 % | 4 % | ... | 100 —104 | 100 - 104 | ... | ... |
| 25,000 | Amazon Telegraph, Limited, shares | 10 | ... | ... | ... | 5 — 6 | 5 — 6 | ... | ... |
| 923,960£ | Anglo-American Teleg., Ltd. | Stock | £2 2s. | £2 9s. | £2 13s. | 58 — 60 | 59 — 61 | 59⅛ | 59 |
| 3,038,020£ | Do. do. 6 % Pref. | Stock | £4 4s. | £4 18s. | £5 6s. | 104½— 105½ | 105 —106 | 105⅞ | 104⅜ |
| 3,038,920£ | Do. do. Defd. | Stock | ... | ... | ... | 12½— 13 | 13⅛— 13⅜ | 13⅛ | 12 13/16 |
| 130,000 | Brazilian Submarine Teleg., Ltd. | 10 | 7 % | 7 % | ... | 15¼— 15⅜ | 15¼— 15⅜ | 15⅝ | 15⅜ |
| 75,000£ | Do. do. 5 %, Debs., 2nd series, 1926 | 100 | 5 % | 5 % | ... | 113 —117 | 113 —117 | ... | ... |
| 44,000 | Chili Telep., Ltd., Nos. 1 to 44,000 | 5 | 2½% | 4 % | 4 % | 3¼— 3⅜ | 3¼— 3⅜ | ... | ... |
| 10,000,000$ | Commercial Cable Co. | $100 | 7 % | 7 % | 7 % | 178 —183 xd | 178 —183 xd | ... | ... |
| 653,586£ | Do. Do. Sterling 500 year 4% Deb. Stock Red. | Stock | ... | ... | ... | 107 —108 | 107 —108 | 107⅝ | 107¼ |
| 224,850 | Consolidated Telep. Const. and Main., Ltd. | 10/- | 1½% | 1½% | 2 % | 7/16— 7/16 | 7/16— 7/16 | ... | ... |
| 16,000 | Cuba Teleg., Ltd. | 10 | 8 % | 8 % | 8 % | 8½— 9⅛ | 8½— 9⅛ | 9⅛ | 8½ |
| 6,000 | Do. 10 % Pref. | 10 | 10 % | 10 % | 10 % | 18½— 19½ | 18½— 19½ | 19⅛ | ... |
| 12,931 | Direct Spanish Teleg., Ltd. | 5 | 4 % | 4 % | 4 % | 4 — 5 | 4 — 5 | ... | ... |
| 6,000 | Do. do. 10 % Cum. Pref. | 5 | 10 % | 10 % | 10 % | 10 — 11 | 10 — 11 | ... | ... |
| 30,000£ | Do. do. 4½ % Debs. Nos. 1 to 6,000 | 50 | 4½% | 4½% | 4½% | 103 —106% | 103 —106 % | ... | ... |
| 60,710 | Direct United States Cable, Ltd. | 20 | 2 % | 2½% | 2½% | 10 — 10½ | 10 — 10¼ | 10 3/16 | 10 3/16 |
| 400,000 | Eastern Teleg., Ltd., Nos. 1 to 400,000 | 10 | 6½% | 6½% | 6½% | 16⅜— 17⅛ | 16⅜— 17⅛ | 17 3/16 | 16 13/16 |
| 70,000 | Do. 6 % Cum. Pref. | 10 | 6 % | 6 | 6% | 17⅛— 18⅛ | 18 — 19 | 18¼ | 17⅞ |
| 89,900£ | Do. 5 % Debs., repay. August, 1899 | 100 | 5 % | 5 % | 5% | 101 —104 | 101 —104 | ... | ... |
| 1,302,615£ | Do. 4 % Mort. Deb. Stock Red. | Stock | 4 % | 4 % | 4% | 130 —133 | 130 —135 | 132⅜ | 132½ |
| 250,000 | Eastern Extension, Australasia and China Teleg., Ltd. | 10 | 7 % | 7 % | 7% | 17½— 18 | 17½— 18 | 18 | 17 13/16 |
| 35,500£ | Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 | 100 | 5 % | 5 % | 5% | 99 —103 | 99 —103 | ... | ... |
| 133,100£ | Do. do. Bearer, 1,050—3,975 and 4,327—6,400 | 100 | 5 % | 5 % | 5% | 100 —103 | 100 —103 | ... | ... |
| 320,000£ | Do. 4 % Deb. Stock | Stock | 4 % | 4 % | 4% | 129 —132 | 129 —132 | ... | ... |
| 51,100£ | Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343 | 100 | 5 % | 5 % | 5% | 99 —103 | 99 —103 | ... | ... |
| 69,200£ | Do. do. do. to bearer, 2,344 to 5,500 | 100 | 5 % | 5 % | 5% | 100 —103 | 100 —103 | ... | ... |
| 300,000£ | Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909 | 100 | 4 % | 4 % | 4% | 103 —106 | 103 —106 | 103½ | ... |
| 200,000£ | Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000 | 25 | 4 % | 4 % | 4% | 108 —111% | 108 —111 % | 110 | ... |
| 180,227 | Globe Telegraph and Trust, Ltd. | 10 | 4½% | 4½% | 4½% | 11½— 12 | 11½— 12 | 11⅞ | 11½ |
| 180,042 | Do. do. 6 % Pref. | 10 | 6 % | 6 % | 6% | 16⅜— 17½ | 16⅜— 17½ | 17½ | 16⅜ |
| 150,000 | Great Northern Teleg. Company of Copenhagen | 10 | 8⅜% | 10 % | 10% | 26½— 27½ | 26½— 27½ | 27½ | 26⅞ |
| 160,000£ | Do. do. do. 5 % Debs. | 100 | 5 % | 5 % | 5% | 102 —105 | 102 —105 | ... | ... |
| 17,000 | Indo-European Teleg., Ltd. | 25 | 10 % | 10 % | 10% | 54 — 57 | 54 — 57 | 54 | ... |
| 100,000£ | London Platino-Brazilian Teleg., Ltd. 6 % Debs. | 100 | 6 % | 6 % | 6% | 106 — 109 | 106 — 1 0 | ... | ... |
| 28,000 | Montevideo Telephone 6% Pref., Nos. 1 to 28,000 | 5 | 4 % | 4 % | ... | 2 — 2½ | 2 — 2½ | ... | ... |
| 484,597 | National Teleph., Ltd., 1 to 484,597 | 5 | 5 % | 5½% | 5½% | 6½— 6⅝ | 6⅝— 6⅞ | 6 13/16 | 6 9/16 |
| 15,000 | Do. 5 % Cum. 1st Pref. | 10 | 6 % | 6 % | 6 % | 15 — 17 | 15 — 17 | 16½ | ... |
| 15,000 | Do. 6 % Cum. 2nd Pref. | 10 | 6 % | 6 % | 6 % | 15 — 17 | 15 — 17 | ... | ... |
| 119,234 | Do. 5 % Non-cum. 3rd Pref., 1 to 119,234 | 5 | 5 % | 5 % | 5 % | 6 — 6½ | 6 — 6½ | 6½ | 6 |
| 1,329,471£ | Do. 3½ % Deb. Stock Red. | Stock | 3½% | 3½% | 3½% | 105 —110 | 105 —110 | 106¼ | ... |
| 171,504 | Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid | 1 | 4½% | 5 % | 5 % | 9/16— 11/16 | 9/16— 11/16 | ... | ... |
| 100,000£ | Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000 | 100 | 4 % | 4 % | 4 % | 107 —110 | 107 —110 | 110 | ... |
| 11,839 | Reuter's Ltd. | 8 | nil | 5 % | 5 % | 7 — 8 | 7 — 8 | ... | ... |
| 3,381 | Submarine Cables Trust | Cert. | ... | ... | ... | 136 - 141 | 136 —141 | 139 | ... |
| 58,000 | United River Plate Teleph., Ltd. | 5 | 3 % | 4 % | ... | 3¾— 4¼ | 3¾— 4¼ | 3⅞ | ... |
| 146,733£ | Do. do. 5 % Debs. | Stock | 5 % | 5 % | ... | 102 —107 | 102 —107 | 104⅛ | ... |
| 15,609 | West African Teleg., Ltd., 7,561 to 23,169 | 10 | nil | 4 % | nil | 5 — 6 | 5 — 6 | ... | ... |
| 213,400£ | Do. do. do. 5 % Debs. | 100 | 5 % | 5 % | 5 % | 103 —106 | 103 —106 | ... | ... |
| 64,256 | Western and Brazilian Teleg., Ltd. | 15 | 3 % | 3 % | 2 % | 9½— 9¾ | 9½— 10 | 9 15/16 | ... |
| 33,129 | Do. do. do. 5 % Pref. Ord. | 7½ | 5 % | 5 % | 5 % | 7½— 7¾ | 7½— 7¾ | 7 9/16 | 7⅜ |
| 33,129 | Do. do. do. Def. Ord. | 7½ | 1 % | 1 % | ... | 2½— 3 | 2¾— 3¼ | 3 | 2⅞ |
| 382,230 | Do. do. do. 4 % Deb. Stock Red. | Stock | ... | ... | ... | 103 —105 | 103 —106 | ... | ... |
| 88,321 | West India and Panama Teleg., Ltd. | 10 | ⅛% | ⅛% | 1 % | ⅜— 1 | ⅜— 1 | ... | ... |
| 34,563 | Do. do. do. 6 % Cum. 1st Pref. | 10 | 6 % | 6 % | 6 % | 10 — 10½ | 10 — 10½ | 10 | ... |
| 4,669 | Do. do. do. 6 % Cum. 2nd Pref. | 10 | 6 % | 6 % | 6 % | 7½ — 8½ | 7½ — 8½ | ... | ... |
| 80,000£ | Do. do. 5 % Debs. No. 1 to 1,800 | 100 | 5 % | 5 % | 5 % | 106 —109 | 106 —109 | ... | ... |
| 1,163,000$ | Western Union of U. S. Teleg., 7 % 1st Mort. Bonds | $1000 | 7 % | 7 % | 7% | 106 —110 | 106 —110 | ... | ... |
| 160,100£ | Do. do. 5 % Ster. Bonds. | 100 | 6 % | 6 % | 6% | 100 —105 | 100 —105 | ... | ... |

### ELECTRICITY SUPPLY COMPANIES.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 30,000 | Charing Cross and Strand Electy. Supply | 5 | 4½% | 5 % | 6 % | 12½— 13⅛ | 12 — 13 | 12¾ | 12⅝ |
| 20,000 | Do. do. do. do. 4½ % Cum. Pref. | 5 | ... | ... | ... | 6 — 6½ | 6 — 6½ | 6 7/16 | 6½ |
| 26,000 | *Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 | 5 | 5 % | 5 % | 5 % | 10 — 10½ | 10¼— 10⅜ | 10 9/16 | 10¼ |
| 60,000 | Do. do. do. 4½ % Deb. Stock Red. | Stock | ... | 4½% | 4½% | 110 —113 | 110 —113 | 111½ | |
| 40,000 | City of London Elec. Lightg. Co., Ltd. Ord. 40,001—80,000 | 10 | 5 % | 5 % | 7 % | 25 — 26 | 25 — 26 | 25⅝ | 25¼ |
| 10,000 | Do. do. Prov. Certs. | 5 | ... | ... | ... | 23½— 24½ | 24 — 25 | 24½ | 24⅜ |
| 40,000 | Do. do. 6 % Cum. Pref., 1 to 40,000 | 10 | 6 % | 6 % | 6 % | 17 — 18 | 17 — 18 | 17⅝ | ... |
| 400,000 | Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid | ... | 5 % | 5 % | 5 % | 130 —135 | 130 —135 | 135 | 133 |
| 22,475 | County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475 | 10 | ... | nil | nil | 12⅜— 13⅛ | 12⅜— 13¼ | 13 1/16 | 12⅜ |
| 20,000 | Do. do. do. 6% Pref., 40,001—60,000 | 10 | ... | 6 % | 6 % | 15¼— 15⅝ | 15¼— 16 | 15 11/16 | 15½ |
| 10,000 | House-to-House Elec. Light Supply, Ord., 101 to 10,100 | 5 | ... | ... | ... | 9 — 9½ | 9 — 9½ | 9 7/16 | 9½ |
| 10,000 | Do. do. 7 % Cum. Pref. | 5 | ... | ... | ... | 10¾— 11¼ | 10¾— 11¼ | 10¾ | 10 13/16 |
| 49,900 | *Metropolitan Electric Supply, Ltd., 101 to 50,000 | 10 | 3 % | 4 % | 5 % | 17¼— 18⅛ | 18 — 19 | 18⅜ | 18⅛ |
| 12,500 | Do. Ord., 50,001—62,500, iss. at £2 prem. | 10 | ... | ... | ... | 16½— 17⅛ | 17 — 18 | 17⅛ | 17⅜ |
| 220,000£ | Do. 4½% first mortgage debenture stock | ... | 4½% | 4½% | 4½% | 118 —122 | 118 —122 | ... | ... |
| 6,452 | Notting Hill Electric Lightg. Co., Ltd. | 10 | 1 % | 2 % | 4 % | 15 — 16 | 15 — 16 | 15⅞ | 15½ |
| 19,980 | *St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080 | 5 | 6½% | 7½% | 10½% | 16½— 17⅛ | 16½— 17⅛ | ... | ... |
| 20,000 | Do. do. 7 % Pref., 20,081 to 40,080 | 5 | 7 % | 7 % | 7 % | 10 — 11 | 10 — 11 | 10¼ | 10⅛ |
| 50,000 | Do. do. 4 % Deb. stock Red. | Stock | ... | ... | ... | 103 —106 | 103 —106 | ... | ... |
| 67,900 | Westminster Electric Supply Corp., Ord., 101 to 80,000 | 5 | 5 % | 7 % | 9 % | 14½— 15½ | 14½— 15½ | 15 | ... |

* Subject to Founder's Shares.
‡ Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
§ Dividends paid in deferred share warrants, profits being used as capital.
‖ Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

## SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

### ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

| Present Issue. | NAME. | Stock or Share ‡ | Dividends for the last three years. 1894. | 1895. | 1896. | Closing Quotation, Sept. 22nd. | Closing Quotation Sept. 29th. | Business done during week ended Sept. 29th, 1897. Highest. | Lowest. |
|---|---|---|---|---|---|---|---|---|---|
| 20,000 | British Electric Traction ... ... ... ... ... | 10 | ... | ... | ... | 13 — 13¼ | 13 — 13¼ | 13¼ | ... |
| 90,000 | Brush Elecl. Engng. Co., Ord., 1 to 90,000... ... ... | 5 | 2½% | ... | ... | ⅞ — 1⅛ | 1 — 1⅛ | 1⅛ | 1 |
| 90,000 | Do. do. Non-cum. 6 % Pref., 1 to 90,000 | 2 | 3 % | ... | ... | 1⅛ — 1⅜ | 1⅛ — 1⅜ | 1⅜ | 1 1/16 |
| 125,000£ | Do. do. 4½ % Perp. Deb. Stock. ... ... | Stock | 4½% | ... | ... | 103 —107 xd | 103 —107 | ... | ... |
| 76,770 | Do. do. 4½% 2nd Deb. Stock Red. ... | Stock | ... | ... | ... | 94 — 98 | 94 — 98 | 91 | ... |
| 19,126 | Central London Railway, Ord. Shares ... ... ... | 10 | ... | ... | ... | 9⅞ — 10¼ | 9⅞ — 10¼ | 10⅛ | 9⅞ |
| 143,103 | Do. do. do. £6 paid ... ... | 10 | ... | ... | ... | 5½ — 6¼ | 5½ — 6¼ | 5⅞ | 5 1/16 |
| 58,830 | Do. do. Pref. half-shares £1 pd. ... | ... | ... | ... | ... | 1¼ — 1⅜ | 1¼ — 1⅜ | ... | ... |
| 61,777 | Do. do. Def. do. £5 pd. ... | ... | ... | ... | ... | 4¼ — 4⅜ | 4¼ — 4⅜ | ... | ... |
| 630,000£ | City and South London Railway ... ... ... ... | Stock | 1¼% | 1 1/16% | 1 1/16% | 67 — 69 | 69 — 71 | 70½ | 68 |
| 28,180 | Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180 | 5 | *nil* | *nil* | ... | 1½ — 2 | 1½ — 2 | ... | ... |
| 89,261 | Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261 | 5 | 5 % | 5 % | 5½% | 2¼ — 2⅜ | 2¼ — 2⅜ | 2 7/16 | ... |
| 17,139 | Do. do. do. "A" Shares 01—017,139 | 5 | 5 % | 5 % | 5½% | 4 — 4½ | 4 — 5 | ... | ... |
| 110,000 | Electric Construction, Ltd., 1 to 110,000 ... ... ... | 2 | *nil* | 5 % | 6 % | 1⅞ — 2⅛ | 2 — 2¼ | 2 1/16 | 1 15/16 |
| 16,343 | Do. do. 7 % Cum. Pref., 1 to 16,343 ... | 2 | 7 % | 7 % | 7 % | 3 — 3½ | 3⅛ — 3⅜ | ... | ... |
| 91,195 | Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000 ... ... | 2 | *nil* | ... | ... | ⅝ — ¾ | ⅝ — ¾ | ... | ... |
| 67,275 | Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ... | 2 | *nil* | ... | ... | ⅜ — ⅝ | ⅜ — ⅝ | ... | ... |
| 9,600£ | Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ... | 10 | *nil* | 10½% | ... | 9 — 11 | 9 — 11 | ... | ... |
| 12,500 | Henley's (W. T.) Telegraph Works, Ltd., Ord. ... ... | 10 | 6 % | 8 % | 10 % | 18½ — 19½ | 19 — 20 | 19⅜ | ... |
| 3,000 | Do. do. do. 7% Pref. ... ... | 10 | 7 % | 7 % | 7 % | 18 — 19 | 18½ — 19½ | ... | ... |
| 50,000 | Do. do. do. 4½ Mort. Deb. Stock | Stock | ... | 4½% | 4½% | 109 —114 | 109 —114 | ... | ... |
| 50,000 | India-Rubber, Gutta Percha and Teleg. Works, Ltd. ... | 10 | 10 % | 10 % | 10 % | 21½ — 22½ | 21½ — 22½ | 21⅝ | ... |
| 300,000 | Do. do. do. 4 % 1st Mort. Debs. | 100 | ... | ... | ... | 105 —108 | 103 —107 | ... | ... |
| 37,500 | Liverpool Overhead Railway, Ord. ... ... ... ... | 10 | 1½% | 2⅝% | 2⅝% | 11 5/16 — 11 7/16 | 11 7/16 — 11 9/16 | ... | ... |
| 10,000 | Do. do. Pref., £10 paid ... ... | 10 | 5 % | 5 % | 5 % | 16 — 16½ | 16 — 16½ | ... | ... |
| 37,350 | Telegraph Constn. and Maintce., Ltd. ... ... ... | 12 | 20 % | 15 % | 15 % | 36 — 39 | 36 — 39 | 38¼ | ... |
| 150,000 | Do. do. do. 5 % Bonds, red. 1899 | 100 | 5 % | 5 % | 5 % | 102 —105 | 102 —105 | ... | ... |
| 54,000£ | Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ... | 10 | ... | ... | ... | 10⅜ — 11¼ | 10⅜ — 11¼ | 11 3/16 | 11 |

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1893—0%; 1894—3%; 1895—5%; 1896—5%.

### LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9⅛.

Electric Construction Corporation, 6 % Debentures, 104 –107.

House-to-House Company, 4½% Debentures of £100, 109 –111

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 13¾—14¼; 1st Preference Cumulative 6 %, £5 (fully paid), 8¼—8⅝. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 2—2¼.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8¼. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 2 per cent. (May 13th 1897).

## BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—TORONTO, 1897.

### SOME TESTS ON THE VARIATION OF THE CONSTANTS OF ELECTRICITY SUPPLY METERS, WITH TEMPERATURE AND WITH CURRENT.

By G. W. Donald Ricks, A.C.G.I., A.I.E.E.

(*Section G.*)

(*Concluded from page* 419.)

*Perry Meter.*

The general principle upon which the action of this meter depends differs from that employed in the Chamberlain and Hookham meter in several respects. Instead of the current passing radially through a permanent magnetic field, the field is radial and the current traverses it perpendicularly, the chief retarding force being due to Foucault currents. It was in this meter that complete immersion of the armature was first used.

Table IV.—*Perry Meter.*

Maximum current, 20 amperes. Current varied. $a = 660$ $K^1 = 2$.

| Current A. | At − 1° C. | | At 19° C. | | At 32° C. | |
|---|---|---|---|---|---|---|
| | *w* | K | *w* | K | *w* | K |
| 1 | 0·0607 | 3·022 | 0·0685 | 2·677 | 0·0724 | 2·534 |
| 2 | 0·1493 | 2·456 | 0·1613 | 2·271 | 0·1700 | 2·152 |
| 5 | 0·3950 | 2·320 | 0·4210 | 2·180 | 0·4432 | 2·069 |
| 7 | 0·5490 | 2·341 | 0·596 | 2·155 | 0·620 | 2·070 |
| 10 | 0·779 | 2·356 | 0·847 | 2·166 | 0·875 | 2·096 |
| 15 | 1·126 | 2·442 | 1·241 | 2·215 | 1·296 | 2·121 |
| 20 | 1·490 | 2·460 | 1·640 | 2·256 | 1·690 | 2·170 |

In the sectional drawing, figs. 6A and 6B, M $M_1$ are a number of permanent magnets, their pole-pieces, $I_1$ $I_2$, being so shaped that they form the boundaries of an annular chamber, S S, containing mercury. In this chamber an inverted copper cup, C, rotates on a vertical spindle pivotted at P and $P_1$. The pivot, P, is placed in a small mercury cup, A, thus ensuring good electrical contact between the fixed and moving parts of the circuit. The whole surface of the

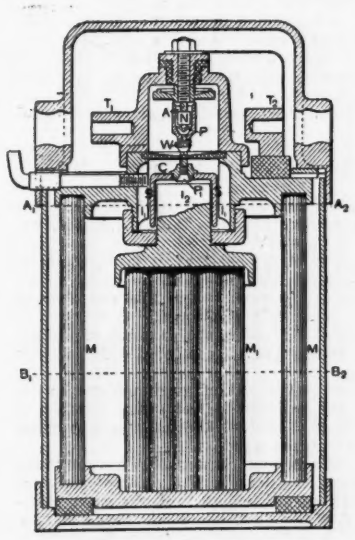



Fig. 6A.

spindle and copper cup, except the rim at the bottom, is insulated from the mercury by a coating of enamel. The current on entering at the terminal, $T_1$, passes to the bottom of the mercury chamber;

then up through the cylinder and spindle to the small mercury cup, A, into which projects the nickelled rod, N, insulated from the case

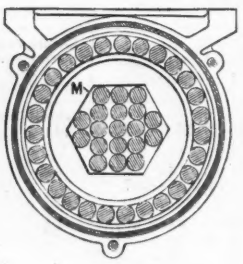



Fig. 6B.

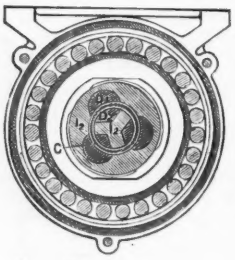



Fig. 6C.

but connected to the other terminal, $T_2$, by which the current leaves the meter.

Solid friction is not compensated for in this meter, but is made very small compared with the other forces, by so adjusting the weight of the copper cylinder that it just floats in the mercury. There is also very little skin friction, because of the very small diameter of the spindle at the part where it passes out of the mercury. In order to make the Foucault friction as large as possible, discontinuities $D_1$ $D_2$ (fig. 6C) are made in the pole-pieces; but the cylindrical form of the mercury chamber is preserved by filling these up with plaster of Paris, the aim being to make the retarding force due to Foucault currents large compared with the other retarding forces—viz., that due to the friction of the mercury against the sides of its chamber, and the solid and skin friction of the spindle.

In considering the law of this meter, let

A = the current,
F = strength of permanent magnetic field.
T = the driving torque,
$w$ = the angular speed of spindle.

Then $T = c\,A\,F$ where $c$ is some constant,

Now the frictional resistance is made up of three parts:—

1. Solid friction at the bearings and skin friction where the spindle passes out of the mercury. Let $r$ equal their combined retarding force; the law connecting $r$ with the speed $w$ is not at all definite.

2. Fluid friction of the mercury on the copper cylinder and on the walls of its chamber. This is an exponential function of the speed, the exponent increasing with the speed. Let $\phi(w)$ be the retarding force due to this cause.

3. Foucault current friction. This is very nearly proportional to the speed and to the square of the strength of the magnetic field, and may therefore be represented by $b\,F^2 w$, where $b$ is some constant.

Hence for steady motion we have

$$T = c\,F\,A = r + \phi(w) + b\,F^2 w.$$

Now the construction of the meter is such the term $b\,F^2 w$ is very much greater than the sum $r + \phi(w)$. As already mentioned this is effected by using a strong permanent magnetic field and by reducing solid and fluid friction to a minimum.

Hence we have that very approximately $c\,F\,A = b\,F^2 w$,

$$A = \frac{b\,F}{c}\,w = k\,w, \text{ where } k \text{ is some constant.}$$

The experimental results obtained from this meter are given in tabulated form in Table IV., and shown graphically on Sheet IV.

The high value of the constant at low currents is undoubtedly due to relative importance of solid and fluid friction as compared with Foucault current friction, for, as already mentioned, the former are not compensated for, and in the equation of motion are assumed to be negligible compared with Foucault friction.

Above about 30 per cent. of maximum current the constant begins gradually to rise, owing possibly to the increased effect of fluid friction, which increases very rapidly with the speed.

The effect of temperature, as shown also on Sheet IV., seems to be considerable. The constant decreases in value with rise of temperature, the mean coefficient being 0·47 per cent. per 1° C. change of temperature. It may be accounted for by the decrease in retarding forces, due partly to the increased resistance of the copper cup, and consequently smaller Foucault current friction, but probably also to the decreased viscosity of the mercury reducing the fluid friction. The weakening of the permanent magnets with rise of temperature would scarcely have any effect on the constant, because it would, except perhaps at very low currents, alter the driving and retarding forces in almost the same ratio. The inaccuracies of this meter with variable temperature are rather large. An alteration of 10° C. for instance causes an error of 4·7 per cent., which is rather serious when it is remembered that the Board of Trade has fixed the maximum permissible error at 2½ per cent.

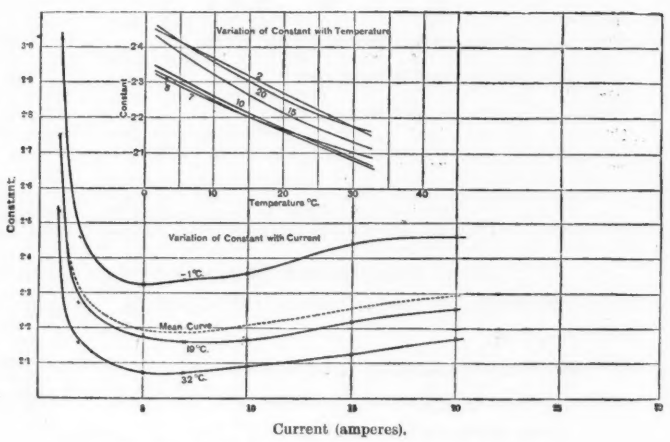
Although possessing such a high temperature coefficient, this meter has several very desirable properties, among which may be mentioned extremely low resistance. Delicate counting mechanism is avoided by having a large brake force; extremely delicate registering gears are very troublesome to keep in order, and will stand only the most careful usage. The use of exceedingly pure mercury is not so essential in this meter as it is in those which rely on mercury for fluid friction. Fairly pure mercury is used to reduce the fluid friction to a minimum.

The permanency of strength of the magnetic field is secured by energising the magnets after they are in position, and then slightly weakening them. The strength of field is adjusted by replacing one or more by pieces of wood until reduced to the required strength. The construction is throughout very compact and durable, and the manner of making connections very convenient.

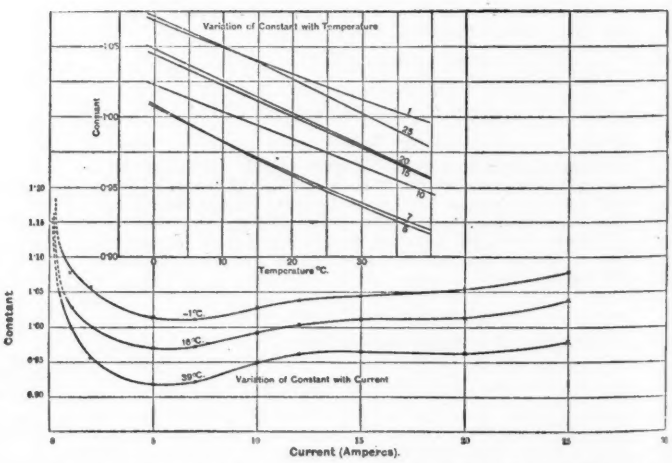
*Chamberlain and Hookham Meter.*

In this meter two metal discs are employed rotating upon a vertical spindle in a permanent magnetic field the direction of which is parallel to the spindle. The current in passing radially through one of the discs gives rise to a driving torque which, since the field is constant, is direct proportional to itself. A retarding torque proportional to the speed is supplied by Foucault currents in the other disc.

In the sectional drawing, fig. 7, M M are permanent magnets enclosed in a brass tube, T. The pieces, N $N_1$, and the wrought-iron pillars, W $W_1$, continue the magnetic circuit to the pole-pieces, P $P_1$




Sheet IV.—Perry Meter (Max. Current, 25 amps.).




Sheet V.—Chamberlain and Hookham Meter (Max. Current, 25 amps.).

between which there is a wrought-iron piece, L. This is held down upon a copper ring, B, which lies upon the flat surface of the lower pole-piece, P, and forms with it a mercury chamber in which the driving disc, D, rotates. The inner surface of the ring, B, is nickel-plated to prevent injury from the mercury. The brake disc, $D_1$, rotates in the gap between L and the upper pole-piece, $P_1$, both of which are deeply grooved radially to increase the Foucault current

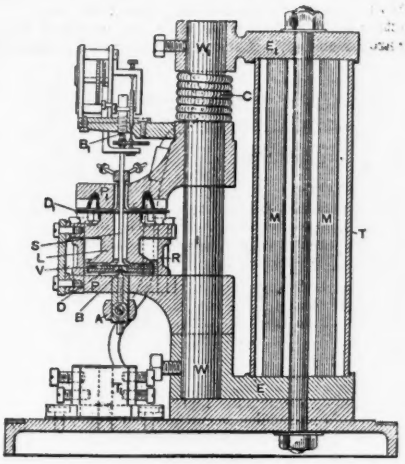


Fig. 7.

effect. This grooving also has the effect of reducing the area of cross-section, causing the projecting radial bars to be partially saturated, the result being that the strength of the brake field is almost independent of the total induction. Besides the retarding force on the brake disc two other retarding forces are present, namely, that due to fluid friction of the driving disc on the mercury, and that due to solid friction at the bearings and in the counting mechanism. These are all made as small as possible and are practically negligible compared with the brake friction.

Table V.—*Chamberlain and Hookham Meter.*

Maximum current 25 amperes. $a = 624$. $K^1 = 1$.

| Current A. | At − 1° C. | | At 16° C. | | At 39° C. | |
|---|---|---|---|---|---|---|
| | $w$ | K | $w$ | K | $w$ | K |
| 1 | 0·1608 | 1·076 | 0·1678 | 1·032 | 0·1768 | 1·00 |
| 2 | 0·3281 | 1·057 | 0·3478 | 0 998 | 0·3640 | 0·953 |
| 5 | 0·856 | 1·011 | 0 897 | 0 966 | 0·945 | 0 918 |
| 7 | 1·200 | 1 010 | 1·250 | 0 971 | 1·316 | 0·922 |
| 10 | 1 688 | 1·026 | 1·750 | 0·991 | 1·830 | 0 9:7 |
| 12 | 2 C02 | 1 038 | 2 073 | 1·003 | 2 168 | 0 960 |
| 15 | 2·480 | 1 046 | 2·578 | 1 010 | 2 700 | 0·963 |
| 20 | 3·290 | 1 052 | 2 435 | 1·011 | 3·615 | 0 960 |
| 25 | 4·030 | 1·075 | 4·176 | 1·037 | 4·430 | 0 978 |

Solid friction at the bearings is reduced to a minimum by the following ingenious arrangement: the floating power of the armature is so adjusted that at small current it is just able to support the weight of the spindle and discs. There is then a very light pressure on the upper bearing, which is very delicate and almost frictionless. As the current increases, however, the centrifugal force of the mercury draws the armature down on to the much stronger and more durable bearing at the lower end. By this means the delicate upper bearing is used only at small currents, when friction has a comparatively large effect. The flotation of the lower disc is adjusted by attaching to it a disc of vulcanised fibre.

A correction is made for fluid friction by slightly increasing the armature-field at higher speeds, without altering the brake-field. This is effected by attaching to the iron piece, L, a flat iron bar (not shown in the drawing) which bends downwards by the side of the lower pole-piece. This forms a magnetic shunt-circuit energised by a few series turns. When the current is very small it weakens the armature-field by shunting some of it, but as the current increases a reversal takes place, the armature-field being strengthened by the shunt induction. Besides this there are a few series windings placed on the upper polar extension of the permanent magnets, and having such a direction as to strengthen the magnets.

The current enters at the rim of the armature disc, passing radially to its centre, and is then led round the two series-windings already mentioned.

The results of the tests on this meter are given in Table V., and shown graphically on Sheet V. Referring to this it will be seen that the constant rapidly decreases as the current is increased, the curve crossing the declared value at about 8 per cent. of the maximum current and having a rather low value till at about 45 per cent. it crosses the declared value again, after which it remains fairly level until within 20 per cent. of the maximum current, when it bends upwards. Solid friction, which, of course, is not compensated for in this meter, must account for the high value of the constant at low currents, and partly uncompensated fluid friction for the final rise. Perhaps also the low value at about 20 per cent. of maximum current may be due to the compensating effect being too great, as it probably would be at low speeds.

The curves showing the effect of temperature are also given on Sheet V. The constant appears to vary in a very uniform manner, inversely as the change in temperature, the maximum effect differing very little from the mean. The mean temperature coefficient is − 0·22 per cent. per °C. It is probably due to the combined effect of the increase of the electric resistance of the brake disc, and decreased fluid friction, both of which would tend to decrease the constant as the temperature rises.

The starting current of this meter was found to be 0·2 ampere, or 0·8 per cent. of the maximum current. Its resistance is also very low and its general construction good.

*General Comparison.*

A very fair idea of the relative advantages and disadvantages of each meter may be obtained from Table VI.

The first two columns simply show the current, and in the case of energy meters the pressure for which each meter is intended. The resistance of the main circuit given in the next two columns was measured by means of a standard ammeter and a standard reflecting voltmeter, and the resistance of the shunt circuits on a Wheatstone bridge.

Considering first the Elihu Thomson meter, it will be noticed that its resistance is comparatively large, the fall of potential at 10 amperes amounting to nearly 0·96 volt. The temperature coefficient is also comparatively large, and the starting current 1·4 per cent. of the maximum current, which is, perhaps, not excessive for this class of meter, especially when used on alternate current circuits.

The Schuckert has an advantage over the Thomson meter in that its resistance is very much less, reducing the fall of pressure and wasted power, but on the other hand its starting current is higher, being 1·93 per cent. of the maximum. Its temperature coefficient is also much less than that of the Thomson meter.

Turning now to the ampere-hour meters, the first point to be noticed is that their resistances are very much lower than is the case with the energy meters. Not only do they save the three or four watts absorbed in the pressure circuit, but the watts wasted in the main circuit appear to be much less.

The Ferranti meter starts with a very small current, 0·8 per cent. of the maximum, and has an extremely low temperature coefficient.

The Chamberlain & Hookham meter has an equally low starting current and a moderate temperature coefficient, its resistance being rather higher than that of the Ferranti for the same maximum current.

The Perry meter has an extremely small resistance, causing a fall of pressure of less than a tenth of a volt at maximum current and absorbing only 1·32 watts. In this respect it is far in advance of all the others, but it has the disadvantages of comparatively high starting current and temperature coefficient.

Table VI.

| Meter. | Max. current in amperes. | Normal pressure in volts. | Resistance in ohms. | | | Power wasted at max. current. | | | Fall of potential in series circuit at max. current. | Starting current per cent. of max. | Temperature coefficient. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Main circuit. | | Shunt circuit. | Main circuit. | Shunt circuit. | Total watts. | | | |
| | | | At 1 ampere. | At max. current. | | | | | | | |
| Elihu Thomson ... ... | 10 | 100 | 0·0948 | 0·0958 | 3.101 | 9 58 | 3 22 | 12 8 | 0 958 | 1 4 | − 0 31 |
| Schuckert ... ... | 15 | 110 | 0·0420 | 0 0438 | 2,535 | 9 9 | 4 77 | 14 67 | 0·66 | 1 93 | − 5 13 |
| Ferranti ... ... ... | 25 | ... | 0·0154 | 0·0131 | ... | 8·19 | ... | 8 19 | 0 327 | 0·8 | + 0 07 |
| Perry ... ... ... | 20 | ... | 0·00327 | 0 00331 | ... | 1 32 | ... | 1·32 | 0 066 | 1·25 | − 0·47 |
| Chamberlain & Hookham | 25 | ... | 0·0137 | 0 0157 | ... | 9 8 | ... | 9 8 | 0·392 | 0·8 | − 0·22 |

*Conclusion.*

In conclusion, the author must acknowledge his indebtedness to

the following gentlemen, who have lent their assistance in various ways: To Prof. Ayrton, for having afforded facilities for carrying out the experimental tests, and for his liberal assistance in supervising the paper. To Mr. Carter and Mr. W. M. Nelson, students at the Central Technical College, the former for his assistance in the laboratory and the latter for having rewritten and arranged the results in their present form. And, lastly, to the manufacturers of the various meters for placing specimens at his disposal.

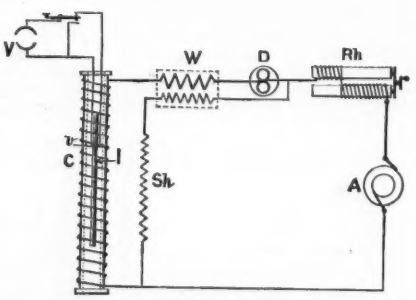
## A METHOD OF DETERMINING MAGNETIC HYSTERESIS LOSS IN STRAIGHT IRON STRIPS.

By J. A. FLEMING, M.A., D.Sc., F.R.S., Professor of Electrical Engineering in University College, London.*

The exact determination of the magnetic hysteresis loss in sheet iron as used for alternating current transformer construction has become of commercial importance of late years. Owing to the obvious necessity for reducing the core loss in transformers to the lowest attainable limit, it is now the custom to carefully test the iron to be used and to express the determined hysteresis loss in the iron sheet, in watts per lb. per 100 frequency, at a maximum induction during the cycle of 2,500 C.G.S. units. Two processes are in ordinary use for effecting this measurement. The most accurate but most tedious is by the employment of a ballistic galvanometer and the graphical delineation of a number of (B, H) cycles. This method has the advantage that it can be conducted with either small or large samples of iron, but the reduction of the observations to give the required hysteresis loss is very tedious; and including the construction of the necessary ring-coil, the actual observations, and the reductions, a single determination of the hysteresis value of an iron can hardly be carried out, even by a couple of industrious workers, in less than a day.

The method employed by Prof. Ewing and Mr. F. Holden of rotating a laminated specimen of the iron in a magnetic field, or rotating a field round the specimen and comparing the torque produced on the field-magnet or on the specimen with that produced by a similar sample of iron of known hysteretic value or else measuring it by a calibrated torsion spring, is very much more rapid. This last method is, however, open to the great objection that if used merely to compare a sample of iron with a standard sample, the user of the instrument is at the mercy of this instrument maker. He receives with it one or more samples of iron which he is told have certain hysteretic values, but he cannot check the truth of the statement. Moreover, if he happens mechanically to injure the standard samples he may seriously change their hysteresis constant. The writer therefore sought for a method which should combine the advantages of both the above processes whilst eliminating their disadvantages, and which should be an absolute method, like the ballistic method, but at the same time a rapid method like the rotating field method.

The following paper contains a description of a process which is based upon the use of the bifilar reflecting wattmeter and operates upon samples of iron, large or small, in the form of straight strips




C, Magnetising coil; V, Electrostatic voltmeter; Rh, Rheostat; I, Iron strips W, Wattmeter; A, Alternator; v, Exploring coil; D, Dynamometer.

which are simply slipped into a long magnetising coil. All the actual practical work and the numerous calculations involved in putting this process to test have been conducted under the author's direction by Mr. A. R. Peart and Mr. W. M. Park working in the Electrical Laboratory of University College, London; and to these gentlemen belongs the full credit for all this portion of the research as well as for the labour required in much tedious numerical and graphical work.

The method is based upon an interesting discovery with regard to the distribution of the induction in a bundle of straight iron strips or iron or steel wires, when placed in a uniform magnetic field.

If a long, straight, magnetising coil is prepared by winding insulated wire upon a paper or vulcanised fibre tube, and if the length of the solenoid is, say, ten times its mean diameter, then for a distance equal to at least three-quarters of the total length of the coil we have a practically uniform magnetic field in the interior of the bobbin, when a constant current is sent through the wire. If into this uniform magnetic field a bar of iron or straight bundle of iron strips or iron wire is introduced, the length of the iron being not greater than the uniform portion of the interior field of the coil when the iron is not there, this iron has magnetic induction created in it which varies in density from point to point in the bar, but is symmetrical in value about the central point of the bar.

The induction density (B) is greatest in the centre of the bar but falls off towards each end. If the magnetising coil is traversed by an

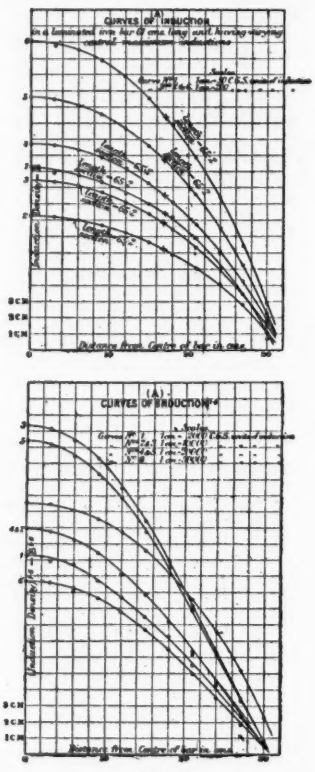



FIG. 1.

alternating current, and if the iron is laminated, the maximum value of the induction density in the bar can be easily determined at any point in its length by placing upon the bar a flat bobbin of fine insulated wire which is connected with an electrostatic voltmeter capable of reading from 1 to 20 volts (see diagram). The first portion of this investigation was concerned with the study of the mode in which this induction density varies from point to point in the length of a bundle of iron strips or iron wire or steel rods of various lengths and diameters, thus placed in the centre of a long magnetising solenoid.

A magnetising coil was prepared, wound on a paper tube, 5·7 centimetres in internal diameter and 99 centimetres long. On this tube was wound, in three layers, a coil of 1,235 turns of cotton-covered copper wire, ·064 inch diameter or of No. 16 size S.W.G. The resistance of this coil was 1·069 ohms at 15° C.

The number of turns per centimetre length of this coil was 12·47. Hence since the interior central field is $4\pi/10$ times the ampere turns per unit of length of the coil, we have thus the value of the field, H, in the central regions of the interior of this bobbin given by the equation

$$H = 15{\cdot}66\ A,$$

where A is the ampere current through the coil.

The secondary or exploring coil consisted of a flat bobbin wound up of silk-covered copper wire ·0024 inch in diameter and having 2,000 turns; the thickness or length of the bobbin being 0·7 centimetre and the external diameter about 4·5 centimetres.

The exploring coil was wound on a circular ebonite former having a rectangular hole in it so as to closely fit the bundle of iron strips to be used, but at the same time it could be slid along the bundle.

The voltmeter used with it was one of Professor Ayrton's low-reading electrostatic instruments of the idiostatic type and read from 1 to 25 volts, the reading being taken by a mirror and scale. The voltmeter was calibrated when required by means of standard cells or a potentiometer.

The first experiments were conducted with strips of transformer iron, kindly furnished to us by Messrs. Sankey. This sheet iron was ·0121 of an inch or ·0307 of a centimetre in thickness and the strips were each 1 inch or 2·54 centimetres wide. The strips used were of various lengths: 60 centimetres, 30 centimetres, 15 centimetres, down to 5 centimetres. A bundle, I (see diagram), of a certain number of strips was made and the secondary coil, v, slipped on to it. The

* Read before the Physical Society on June 11th, 1897, and printed in the *Philosophical Magazine* for September, 1897.

magnetising coil, C, was then traversed by an alternating current having a frequency of 80, and the R.M.S. (root mean square) value of the current was read by a dynamometer, D, or Kelvin balance.

The electrostatic voltmeter, V, being connected to the ends of the secondary coil gave the R.M.S. value of the induced electromotive force set up in the exploring coil. The form of the curve of the primary current was very nearly a true sine curve, and the variation of induction density in the iron at any point closely followed the same law.

In any case, if $f$ is the *form factor** of the secondary voltage curve,

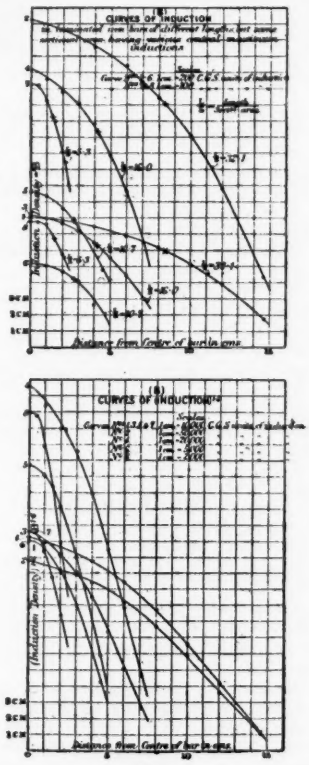


Fig. 2.

which in these experiments was 1·13, and if

N = the number of windings in the secondary coil,
S = the total cross-section of the iron,
B = the maximum value of the induction density in the iron in C.G.S. units at that point in its length at which the secondary coil is placed, and
$n$ = the frequency of the induction cycle; then if $e_2$ is the R.M.S. value of the secondary electromotive force in volts as measured by the voltmeter, we have always

$$10^8 e_2 = 4 f N S B n.$$

Hence the maximum value of the induction density, B, can be calculated from the known value of all the other quantities. In this manner a large number of measurements of the value of the induction density, B, were made at different points in the lengths of various bundles of iron strips of different lengths and total cross-sections.

These values were then laid down in a series of induction density curves so drawn that the ordinates represented the maximum value of the induction density in the bar at different transverse sections along the half-length of the bar, taken as corresponding abscissæ.

It has been shown by Steinmetz and fully confirmed by others that for most varieties of iron used for electrotechnical purposes the hysteresis loss in the iron, per cycle of induction, per cubic centimetre varies as a power of the maximum value of the induction density, which is very nearly 1·6, when that maximum value of the induction density has any value below about 9,000 C.G.S. units. Hence, if the ordinates of the above-mentioned induction curves are all raised to the 1·6th power and a new curve plotted showing the variation of $B^{1\cdot6}$ along the half-length of the bar, we have another curve which represents the variation of the hysteresis loss per unit of volume along the half-length of the bar from point to point. A large series of such curves showing the variation of B and $B^{1\cdot6}$ were drawn for bundles of iron strips and steel of different lengths and sections, and the results are collected and represented in the form of curves in the diagrams.

The upper curves in each case in the figs. 1, 2, and 3 represent the variation of B along the half-length of the bar, and the lower curves the corresponding curves for the variation of $B^{1\cdot6}$. The first pair of diagrams represent the result of varying the maximum induction density in the centre of a bundle of strips of iron of the same length and section.

The second pair of diagrams give the curves showing the same

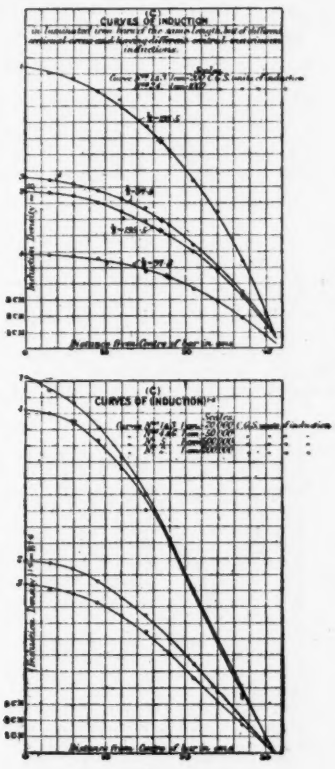


Fig. 3.

results for bundles of iron strips of varying lengths but the same section.

The third pair for various samples of iron strips of the same length but different section.

It is clear from these diagrams therefore that such a bar or bundle of iron strips placed in an originally uniform magnetic field has a non-uniform induction density produced in it at its various points, which is symmetrical about the centre; and a non-uniform hysteresis loss per unit of volume also symmetrical about the centre. The maximum values of each being at the centre of the bar.

Table I.

*Summary of experiments made to ascertain the "Effective point" in bundles of annealed Transformer Iron Strips (Sankey's) when placed in a uniform alternating magnetic field.*

| Reference letter diagram. | Length of specimen in centims. | Sectional area of specimen in sq. cms. | Induction at centre of bar, B. C.G.S. units. | Effective induction, $B_1$, C.G.S. units. | Ratio of $\frac{B_1}{B}$ | Distance of effective point from centre of bar. | Fraction of half-length of bar from centre at which effective induction exists. |
|---|---|---|---|---|---|---|---|
| $A_1$ | 61 | ·936 | 564 | 420 | ·744 | 17·01 | ·558 |
| $A_2$ | 61 | ·936 | 1,648 | 1,240 | ·752 | 16·91 | ·554 |
| $A_3$ | 61 | ·936 | 2,084 | 1,563 | ·750 | 16 92 | ·555 |
| $A_4$ | 61 | ·936 | 2,536 | 1,900 | ·749 | 17 00 | ·557 |
| $A_5$ | 61 | ·936 | 3,112 | 2,335 | ·712 | 17·00 | ·557 |
| $A_6$ | 61 | ·936 | 3,816 | 2,870 | ·752 | 17·10 | ·561 |
| $B_1$ | 30 | ·936 | 1,597 | 1,192 | ·746 | 8 36 | ·557 |
| $B_2$ | 30 | ·936 | 4,052 | 3,012 | ·743 | 8·35 | ·557 |
| $B_3$ | 15 | ·936 | 1,622 | 1,265 | ·780 | 4·11 | ·548 |
| $B_4$ | 15 | ·936 | 3,430 | 2,660 | ·775 | 4·18 | ·557 |
| $B_5$ | 10 | ·936 | 1,907 | 1,554 | ·815 | 2·73 | ·546 |
| $B_6$ | 10 | ·936 | 1,025 | 833 | ·813 | 2·76 | ·552 |
| $B_7$ | 5 | ·936 | 1,622 | 1,420 | ·875 | 1·39 | ·556 |
| $B_8$ | 5 | ·936 | 778 | 678 | ·871 | 1·49 | ·596 |
| $C_1$ | 61 | ·312 | 3,485 | 2,565 | ·736 | 16·84 | ·552 |
| $C_2$ | 61 | ·312 | 9,673 | 7,250 | ·749 | 16·81 | ·551 |
| $C_3$ | 61 | ·624 | 2,125 | 1,570 | ·739 | 17·07 | ·560 |
| $C_4$ | 61 | ·624 | 5,834 | 4,420 | ·758 | 17·60 | ·577 |

Mean of last column = ·56.

* See "The Alternate Current Transformer," Fleming, Vol. i., new ed., p. 583, for a reference to this term.

Table II.—*Summary of Tests made as in Table I. upon Steel and Hard Iron Rods.*

| Reference letter to diagram. | Length of specimen in centims. | Sectional area of specimen in sq. cms. | Induction in centre of bar, B. C.G.S. units. | Effective induction, $B_1$. C.G.S. units. | Ratio of $\frac{B}{B_1}$ | Distance of effective point from centre of bar in cms. | Fraction of half-length of bar from centre at which effective induction exists. | Nature of bar. |
|---|---|---|---|---|---|---|---|---|
| $C_6$ | 61 | ·970 | 4,499 | 3 525 | ·783 | 6 90 | ·58 | Round bar of silver steel $\frac{7}{16}$-inch in diameter. |
| $D_2$ | 32 | ·178 | 5,997 | 4,784 | ·798 | 9·80 | ·61 | Round rod of silver steel $\frac{3}{16}$-inch in diameter. |
| $D_3$ | 32 | ·534 | 5,555 | 4,244 | ·764 | 9·31 | ·58 | Three similar pieces of steel. |
| $D_4$ | 20 45 | ·645 | 4,746 | 3,587 | ·756 | 6·67 | ·65 | Bundle of 60 iron wires of hard iron of rectangular section. |
| $D_5$ | 20 45 | ·645 | 2,545 | 1,912 | ·751 | 6·76 | ·66 | |

If we take the true mean value of the varying distributed hysteresis loss per unit of volume, it is obvious that at some point in the half-length of the bar there must exist an actual induction density, $B_1$, such that the true mean hysteresis loss in the whole bar is proportional to $B_1^{1.6}$. Let this value of the induction density be called the *effective value*, and the point in the bar at which it occurs the *effective point*. Then the effective value, $B_1$, must be equal to the 1·6th root of the mean of the 1·6th powers of the actual induction densities taken at equidistant points all along the bar, or

$$B_1 = \sqrt[1.6]{m \,.\, B^{1.6}}$$

where $m \,.\, B^{1.6}$ stands for the mean ordinate of the curve representing the varying values of $B^{1.6}$ all along the half-length of the bar.

If then this effective value $B_1$ of the induction density is calculated for each of the samples of iron strip used, and the position at which the actual induction has this effective value is marked off on the half-length of the bar (this position is represented by the *cross* on the curves), we have noticed the remarkable fact that *whatever the length or section of the iron strip may be, the point in the bar at which the actual induction density has a value equal to the effective value, always comes at the same proportional distance from the centre of the bar; and this distance is very nearly equal to ·56 of the half-length of the bar from the centre or at ·22 of the whole length of the bar from one end.*

Table I. embodies all the results taken with bundles of annealed transformer iron strip (Sankey's) of very different lengths and sections, and Table II. similar observations on rods of steel and hard iron; and it will be seen that the effective induction in the case of the iron strip is always found at a point in the bar or bundle which is very nearly 0·56 of the half-length of the bar from the centre. If, therefore, the secondary coil is placed at that spot and the secondary voltage then observed used to calculate the induction density, the value so obtained is that which corresponds to the true mean value of the varying hysteresis loss per unit of volume all along the bar. In other words, if we suppose the bar magnetised by an alternating current uniformly and with a maximum induction density everywhere equal to that which it actually has under normal conditions at 0·56 of the half-length of the bar from the centre; then the hysterisis loss in such a bar would be equal to that found in the bar as it is. In all cases where induction density values are given, these are to be understood as being the maximum values during the cycle unless otherwise stated. The frequency of alternations used was 80.

*(To be continued.)*

## NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

### NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

20,972. "Improvements in or relating to contact breakers for X-ray induction coils, &c." H. W. Cox. Dated September 13th.

20,985. "Improvements connected with electric lamps and switches." W. M. Walters. Dated September 13th.

20,996. "Improvements in electrical cut-outs." C. M. Dorman and R. A. Smith. Dated September 13th.

21,036. "Self-registering meter for an alternating electrical current." G. W. Walker. Dated September 14th.

21,054. "Improvements in and relating to surface contact electric railway systems, electric cars and their equipment and automatic switches for use therewith." The British Thomson-Houston Co., Ltd. (E. M. Hewlett, United States.) Dated September 14th. (*Complete.*)

21,055. "Improvements in and relating to electric cars and surface contact railways." The British Thomson-Houston Co., Ltd. (E. M. Hewlett, United States.) Dated September 14th. (*Complete.*)

21,078. "Improvements in the method of utilising the rise and fall of the tide, canals, rivers, and surface waters for generating electricity for lighting and all its various purposes or creating other motive power by its use." T. McNamer. Dated September 14th.

21,100. "Improvements in alternating electric current generators." W. R. Lake. (R. S. Walker, United States.) Dated September 14th. (*Complete.*)

21,109. "Improvements in the bobbins and cores of solenoids for enclosed electric arc lamps." W. J. Davey and G. Thomas-Davies. Dated September 14th.

21,110. "Improvements in arc lamps with double globes." W. H. Wheatley. (Allgemeine Elektricität's Gesellschaft, Germany.) Dated September 14th. (*Complete.*)

21,111. "Improvements in the attachment of pole pieces" W. H. Wheatley. (Allgemeine Elektricität's Gesellschaft, Germany.) Dated September 14th. (*Complete.*)

21,119. "An improved reflector for electric incandescent lamps." J. Haubois. Dated September 14th.

21,154. "Improvements in electro-plated wares." W. H. Jones and B. H. Jones. Dated September 15th.

21,157. "Magnetic and electric measuring instruments." J. Russell. Dated September 15th.

21,178. "Improvements in and relating to the treatment of solutions of carbonate of soda resulting from electrolysis of chloride of sodium and in apparatus applicable for use therein." J. Hargreaves. Dated September 15th.

21,180. "Improvements in dynamo-electric machinery." J. S. Lewis and F. T. Howitt. Dated September 15th.

21,184. "Improvements in switches for use in electric traction systems." M. Walker. Dated September 15th.

21,186. "Improvements in primary batteries." F. H. Perry. Dated September 15th.

21,195. "An improved continuous current dynamo-electric machine." A. E. Badger. Dated September 15th.

21,229. "An improved portable electric battery." D. Forbes. Dated September 16th.

21,249. "Methods of and apparatus for preventing the sticking through leakage currents or the like of electric railway section switches." J. G. Lorrain. (The Esmond International Electric Traction Company, United States.) Dated September 16th.

21,293. "Improvements in signal telegraph apparatus," C. V. Boughton. Dated September 16th.

21,357. "Improvements in and connected with electric traction on the accumulator system." E. J. Wade and A. W. Southey. Dated September 17th.

21,366. "An improved electric arc light reflector." C. M. Bolles. Dated September 17th.

21,395. "Improvements in electric cables and in the manufacture of the same." M. J. P. O'Gorman. Dated September 17th.

21,410. "Improvements in transformers, impedance coils and the like." W. E. Burnand.

21,420. "Improvements in apparatus to be used in connection with the electro-plating of small articles." R. F. Hall. Dated September 18th.

21,437. "An improved method of raising and lowering electric light pendants." R. W. Braham. Dated September 18th.

21,462. "Improvements in or relating to street boxes of electricity mains, tramway cables, or analogous road receptacles." H. W. Wilkinson. Dated September 18th. (*Complete.*)

21,484. "Improvements in electromotors." W. R. Lake. (R. Arno, Italy.) Dated September 18th.

### ABSTRACTS OF PUBLISHED SPECIFICATIONS.

*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d* (*in stamps*).]

#### 1896.

6,732. "Improvements in and connected with advertising devices operated by an electric current." J. H. Collings. Dated March 27th, 1896. The invention relates to certain improvements connected with advertising devices operated by an electric current which may be derived from an existing main circuit, either alternating or continuous current systems, or an independent source. The invention is an improvement upon 6,780, of 1894. 5 claims.

7,789. "Improvements in electric arc lamps." Dated April 13th, 1896. J. Brockie. Relates to an electric arc lamp wherein a carbon holder is suspended by a cord passing over a pulley provided with a stop, so arranged that the pulley is free to move offering no appreciable resistance when the arc is being struck and the carbons are returning to feeding position, but that it operates as a brake retarding the cord in its feeding movement. 1 claim.